EXPLORING SCIENCE

Three

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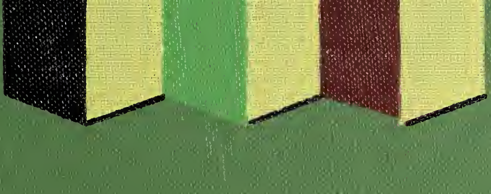

CURRICULUM

Teachers' Edition

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Teachers' Manual for

EXPLORING SCIENCE

Three

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Introduction

PUTTING SCIENCE IN THE CURRICULUM

"Learn through doing!" Study things—not ideas!" What excellent precepts for a science programme! For children love to "do" more than they care to sit passively. And they learn best when they are using their senses to study the world about them.

Imagine a cheerful classroom with children taking care of radish seedlings and goldfish; with children keeping records of tadpole growth and weather changes; with children making model boats and cricket cages; with children comparing what books say about robins with their own observations; with children experimenting, arguing about results, and suggesting new ways to prove that there is water in the air.

This is a picture of a science programme that is meant for children. These children are learning more than isolated facts; they are learning to work together, to solve problems, to handle tools, to use books. And they love every moment of it!

Teaching like this is fun. The outcomes are highly satisfying. Children need only the ideas for things to do, a little help in finding materials, and some encouragement. They supply the necessary enthusiasm and energy.

Some Reasons for Elementary Science

The elementary school is concerned with the growth of the child, —his intellectual, social, emotional, and physical growth. All subject-matter areas have the same general objectives, but they use different methods and content for attaining them. Science, because it deals so much with tangible things, makes several unique contributions.

Much of the programme of the Exploring Science Series involves manipulation, thus developing muscular co-ordination, skill with tools, and familiarity with materials. A number of otherwise outstanding pupils are seriously deficient in manipulative ability, this phase of their education having been neglected. They benefit greatly from opportunities to work with the "things" of the science programme. In contrast, there are a number of retarded readers who find in this phase of science their only opportunities to equal or excel their classmates.

A rich variety of science projects gives all children opportunities for self-expression. Some children best express themselves by making models; some through making friezes, charts, and posters; some by writing science stories, keeping notebooks, and producing science plays; some through collecting and exhibiting.

Science activities encourage pupils to plan, to use ingenuity, and to exercise initiative. When the activities are carried out by small groups, the pupils learn to plan and work together, to share responsibilities, and to assume leadership.

Experiments, field trips, projects, and similar activities stimulate pupils to turn to books for information. By comparing what authorities say with their own observations, the pupils tend to become more critical and they develop habits of open-mindedness and delayed judgment.

Certain phases of the subject matter of science have immediate and important values. Especially important are the learnings that contribute to establishing better health and safety practices. A large share of health and safety education is based upon scientific information. Another area that benefits from science subject matter is conservation education; so closely is conservation allied with science that the two are usually included in the same programme. (Pages 16–18 of this Teachers' Edition discuss the role of science in conservation and health and safety education.)

How Much Time for Science?

"Can you afford fifteen minutes three times a week for science?" This in answer to teachers who are concerned about the already crowded class curriculum. Successful science programmes have been carried out with as little time as this scheduled for science class work. More time is to be desired, but there need be no sacrifice of other important areas when science is added to the school programme.

An elementary science programme does not demand a great deal of formal class time to keep it progressing satisfactorily. Three or four short periods weekly, or the equivalent, are adequate for pupil motivation, with much of the actual science work being carried on outside class time. Most of the units in the Exploring Science Series require two or three weeks for satisfactory development—for planning, experimenting, and discussing.

Science does not require much class time because children make time for science. They find the work too exciting to be dropped between lessons. They rush to school in the morning to see how their plants and animals have fared through the night. They use much of their free time during the school day for science activities. If permitted they will stay after school to work with science materials. And it is not unusual for a majority of the pupils to repeat at home the experiments they have carried out during their science lessons.

It is possible to make science the core of the entire school programme; many children prefer to make science just that. Many children prefer to talk and write about science for their language work; many prefer to read about science during reading periods; some prefer to base their art work on science subjects. As one teacher put it, "I have learned how to start a science programme. Now show me how to stop it!"

Planned and Incidental Science

A planned programme ensures steady progress from grade to grade with a minimum of overlapping and repetition. A planned programme ensures breadth of content and a balance among the various subject-matter areas of science.

A planned programme gives point and direction to the work of the pupils and keeps their enthusiasm high. It opens up new avenues for exploration. Without planning, science programmes usually become haphazard and are sometimes neglected.

On the other hand, there should be time available for what is called "incidental" science. Pupils should have an opportunity to watch a butterfly that has just emerged or to study a rainbow that has just appeared in the sky. Incidental science deals with the unexpected; it is often responsible for some of the most worth-while outcomes of the science programme.

Equipment for the Science Programme

Mayonnaise jars, tin cans, paper clips, and soda straws—such are the materials needed for a science programme. There is nothing mysterious about these commonplace materials. When a child does an experiment with a mayonnaise jar he is working with something familiar to him. He can repeat the experiment at home if he wishes. To him, science is the study of familiar things.

A list of materials needed for each unit of the Exploring Science Series is included in the specific suggestions for teaching each unit. A list of all the science materials needed for the year's programme is included at the end of this Teachers' Edition. Children can supply most of the items, such as tin cans and glass jars. Some of these should be stocked in quantities so that there is always a supply on hand.

It is well to make a list of materials that children cannot bring in. This list may include such raw materials as soft pine lumber, wire, nails, and screws. The list should then be discussed with the principal or the supervisor for items that can be supplied by special departments of the school system. Usually only a few items need be purchased separately.

Ideally, materials for an activity programme should be provided in quantity. Instead of a single hand lens, a class of thirty children should have at least fifteen hand lenses. Although this may seem prohibitively expensive it need not be so. Other teachers in the school will probably be able to use the same materials. By providing a central storage space, and by working out a schedule for the use of the materials, the per-pupil cost becomes insignificant.

HOW TO USE THE BOOKS

Each pair of facing pages in the books of the Exploring Science Series sets the stage for an exciting adventure in science—an experiment, a demonstration, a field trip, a class project. The books are study guides rather than science readers. They present a programme to the pupils and show them how to carry it out.

Some teachers may choose to follow the books page by page, deviating little from the programme as it is presented. Their classes will be meaningful and fun for the pupils.

Other teachers will prefer to modify the programme to fit their special needs. Each book has been planned to permit a high degree of flexibility. How to take advantage of this flexibility and other features are discussed below.

How the Books Are Organized

Science experiences form the basis for the Exploring Science Series. Emphasis is upon first-hand experience activities supplemented by information given through pictures and reading.

The activities have been selected to provide experiences in all the common areas of science, both physical and biological. This presents a well-rounded programme that appeals to different interests and gives a broad background in science.

The activities are grouped in units centred about such familiar subjects as "Mirrors" and "Sunshine" rather than in units of formalized science. A single unit can, and often does, cut across several conventional subject-matter areas.

The material of a unit is developed in two-page blocks, each of which usually takes up a separate topic. This is a successful pattern often found in how-to-do-it books. It is useful in these science books because pupils can carry out an activity without turning pages.

The Teachers' Editions

The special Teachers' Editions for the Exploring Science Series contain the material given in the pupils' editions together with detailed suggestions for using this material.

Each unit is introduced with a discussion of the possible outcomes of the unit and a description of the part the unit plays in the entire science programme. Necessary materials are listed. Different methods of developing and enriching the unit are suggested, and valuable background information is provided.

Following these general helps, the material in the unit is considered page by page. Different methods of developing lessons are suggested. There is advice about the use of tools and materials. Possible difficulties are anticipated, and suggested things for the teacher to say in the classroom are in bold-face type. Answers to questions pupils might ask, follow-up activities, and references are listed. See PREPARING FOR THE UNIT for the best time to begin a unit.

The Teachers' Editions give teachers confidence in their ability to teach science. The Teachers' Editions help teachers to take full advantage of the special features of the books, thus providing a rich and challenging programme.

Scheduling Science

Most of the units in the Exploring Science Series require two or three weeks for satisfactory development. Children should not be hurried through a science programme. They need time to experiment, to discuss results, to try experiments again. They need time between lessons, too. A pupil who has connected a dry cell to an electric lamp during a science lesson will want to repeat the experience during his free time. He may also wish to repeat the experience at home.

Most of the two-page blocks of a unit serve as the subject for one or more lessons each. One of these blocks may describe an activity that requires a full lesson for completion. Some of the activities may be started in one lesson, as with many experiments with plants, and then finished during a lesson at a later time. Field trips require additional lessons for preparation and for follow-up. Projects usually require several lesson periods.

It is recommended that the minimum time allotment for science be scheduled as lesson periods. Additional time can be used for incidental science or for extending scheduled lesson periods as needed.

There are several ways to provide additional science time without scheduling it at the expense of other subjects. If there is a "science table" at the side of the room, materials may be placed on it for pupils to use in their free time, both in and out of school hours. Individual projects can be started in school and completed at home. There can be correlation with reading, language, art, and social studies. As long as the science programme is interesting, the pupils will find time for it.

Modifying the Basic Programme

Perhaps spring comes early to your section of the country. Perhaps your community makes much of Fire Prevention Week. The teaching calendar should recognize these and other important events. The flexibility of the Exploring Science Series makes it possible to shift units as desired because the units within a book are independent of each other. A unit involving fire can be moved to early fall, and a unit involving spring can be scheduled for the time when daffodils burst from the ground.

Likewise the material within a unit may be re-organized to take advantage of special conditions. Re-arrangement of the two-page blocks may permit a more suitable activity to open a unit. Additional activities can be inserted as desired. One may also delete some of the activities that do not seem appropriate to the teaching situation.

The class may wish to take up science material that is not included in the programme of the books. This is admirable and the class should be given every encouragement. There are a few cautions that should be observed. The teacher should be sure that the subject is of interest to all pupils and not to just a few of the more aggressive individuals. She should be sure that there are suitable activities to be used in teaching the proposed subject. She should try not to take up material that will be taught by teachers in later grades. If pupils suggest a topic that does not seem suitable for the entire class, the topic may be assigned to certain interested pupils as optional work. Assigning a particular topic to a superior child will frequently re-awaken his interest by confronting him with a real challenge to his ability.

Beginning a Unit

To start children thinking about magnets put magnets in their hands. To start them thinking about frogs put a frog where they can watch it. That is all there is to starting a new unit.

New materials may be presented in several ways. Sometimes, as with magnets, the materials may be put in the hands of the pupils with little explanation. Sometimes an interesting demonstration can be used; for example, a "race" with burning candles under various-sized jars to see which candle goes out first. Living things, particularly things that move, need only be placed where pupils can watch them.

Special days and special events offer possibilities for introducing new topics. A St. Patrick's Day carnation raises questions that lead to experiments with water movement in plants. Coloured Easter eggs raise questions about dyes that lead to experiments with dyeing cloth.

First-hand experiences make the most interesting and the most challenging approaches to new units. There can be no one best approach to a unit because conditions vary so much, but a little imagination adapts most activities to meet the situation.

Developing a Unit

The pattern in which the material is presented in the Exploring Science Series is one that has been used successfully, but it is not necessarily the most satisfactory for a particular situation. There can be no one best pattern: much depends upon the interests of the pupils, upon the teaching situation, and upon unpredictable events. A teacher should feel free to modify any unit—re-arranging the topics, adding material, and deleting material.

It is important that there be variety in a unit. Variety keeps interest high and provides for individual differences. Use experiments, field trips, demonstrations, model-making, and science play-writing, to obtain the necessary variety.

Different types of activities make different contributions to a science programme. Experiments and field trips provide the basic first-hand information. Study of books and pictures supplements first-hand information with information that has been gained by other people in different situations. Model-making, play-writing, and similar activities serve to organize information.

These books make use of many different types of activities in the development of the programme. The detailed sections of these Teachers' Editions suggest still more types of activities that can be used to enrich the programme.

Evaluating Outcomes

As yet, no one has discovered how to measure the truly important outcomes of a science programme. Certainly the facts of science as tested by pencil-and-paper tests are of small consequence. The important outcomes are the attitudes that pupils develop, the skills they gain, and the habits they acquire.

Evaluation of the effectiveness of a science programme is chiefly one of personal judgment. One must depend upon many small but significant signs. One may look for signs of general interest. How many pupils participated in each activity? How many children volunteered for optional activities? How many pupils brought in materials when asked to do so? How many brought in materials without being asked? How many pupils repeated science activities at home? Did pupils talk about their science experiences outside school?

Specific achievements can be used as a measure of success. What experiments were carried out? What field trips were taken? What projects were completed? What books were read?

One may look for signs of pupil growth. How many normally quiet children took active parts in class work? How many passive children took on leadership responsibilities? How many "slow" readers turned to books for information? How many pupils turned out work of improved calibre?

To measure the progress of individuals look for interest, effort, growth, and achievement. Not all children can be judged by the same standards, but if in his own way a pupil has shown evidence of each of the above, one may feel satisfaction with the results.

SPECIAL TECHNIQUES FOR TEACHING SCIENCE

Most of the teaching techniques used in other subject-matter fields apply equally well to science teaching. But when pupils begin to experiment, to perform demonstrations, to take field trips, and to build models, it is obvious that a teacher must have a knowledge of some additional teaching techniques.

The majority of the activities suggested in the Exploring Science Series are direct experience activities. They are simple and they are clearly described in the textbooks. A teacher should have little difficulty in helping pupils to carry them out, but if difficulties do arise, the detailed assistance given in the Teachers' Editions should quickly clear them up. The real problem that faces a teacher is not that of giving technical assistance with activities: the problem is finding ways to help pupils to gain the most from the experiences.

Science education stresses a number of major goals such as the development of critical thinking and the habit of withholding judgment. The activities which pupils carry out set up the situations that permit these goals to be attained. It is in working toward these major outcomes that many elementary teachers need help.

The Problem-Solving Approach

What a child learns may be of less value to him than the way he learns it. A curious child can be led to speculate, to experiment, to check conclusions. He can be given practice in defining problems.

He can be given opportunities to exercise his ingenuity. He can be encouraged to develop a critical attitude and an open mind. Such experiences are worth more to him than the bits of information he may pick up.

Elementary science is well-adapted to the problem-solving approach. The materials of science awaken curiosity: "How did this dandelion get in my garden?" "How can I connect this dry cell to an electric bell?" "Why does my dog prick up his ears when he wants to hear better?"

It must be remembered, however, that questions do not automatically become problems. A teacher may ask, "How do the people of Canada get their drinking water?" only to discover that few children care. Children are more interested in small and immediate problems: "How can fish stay under water?" Teachers should always re-examine the problems they intend to use to be sure that they have problems which challenge the pupils.

Answering Questions

It is a matter of courtesy to recognize all questions that pupils raise, whether the questions seem relevant or irrelevant, intelligent or silly. Perhaps if we could know all that goes on in a child's mind we would consider all his questions more seriously.

Recognition of a question does not mean that the question must have an immediate answer. Teachers probably answer too many questions for the good of the child. When a teacher answers a question, or selects one of the pupils' guesses as correct, there is nothing more for the pupil to do. It is better to encourage him to speculate, experiment, observe closely, and turn to recognized authorities for information to answer his own questions.

The more a teacher knows of a subject the easier it is to avoid the direct answer in favour of suggestions for finding answers independently. But when a teacher's background in a field is limited, it is still possible to make suggestions that send a pupil to experiments and to books for information—and for the answers.

A teacher must often say, "I don't know, but . . ." and follow up with suggestions for planning an experiment, or with the name of a recognized authority. There are innumerable questions that neither the teacher nor anyone else can answer. Physicists do not know why a magnet picks up iron. Biologists do not know why a bobolink migrates to South America in autumn. No one knows why the earth pulls things toward it or how a green plant produces sugar. The teacher must never be afraid to say, "I don't know." These are the words that challenge mankind. Perhaps that teacher's pupils will be the very ones to solve these age-old questions.

Experiments

Children love to experiment—to find out by "doing," as compared with learning through reading and being told. This is because children like to manipulate, they like to see things happen, there is an element of suspense involved, and perhaps they subconsciously recognize the validity of information gained in this way.

Experiments in the elementary school should be informal. Problems are best stated in the words of the children. There is no place for the formalized pattern of "objective, apparatus, procedure, observations, and conclusions."

The best problems for experiments are the small problems that can be solved with simple equipment and in a short time. "Can a magnet attract a paper clip through cloth?" "Will grass turn yellow when a board is laid on it?" "Will cocoa pass through a filter?"

A number of worth-while problems arise from discussions that pupils hear at home. "Does hot water freeze faster than cold?" Will aspirin tablets keep cut flowers from wilting?" "Is the coldest place in a room near the floor?"

Certain problems are too broad for children to solve. "Do plants need light in order to live?" "Does a fire need air in order to burn?" It would be improper to let pupils feel that they had answered such questions after two or three experiments. Instead of such problems, pupils should be encouraged to work on more limited problems: "Do bean seeds need light in order to start growing?" "Will a candle burn longer in a quart jar than in a pint jar?"

While pupils are carrying out an experiment, the teacher should refrain from influencing their conclusions. Only after the pupils begin to discuss their results should the teacher begin to raise questions that will encourage them to modify their conclusions. Perhaps the pupils have discovered that a pot of corn seedlings in a dark closet died after six days. Some of the pupils have decided that corn seedlings need light in order to live. The teacher may now suggest that the seedlings might have died anyway, perhaps because the soil was poor. She may then encourage the pupils to set up the experiment with another pot of seedlings in a light place.

Teachers are sometimes upset because an experiment does not "work." Actually, all experiments "work" in that they show that something happens or fails to happen. When an experiment does not turn out as anticipated, it is because some unconsidered factor has entered or because the expected result is wrong. But that is the fun of experimenting, not knowing what the results are going to be and trying to account for what does happen.

Field Work

The Exploring Science Series encourages field work as one of the most effective methods of learning science. Few are the units that do not suggest directly or indirectly some type of field work.

Possibilities for field work are almost endless. School buildings often have heating systems, gymnasiums, shops, kitchens, medical centres, and the fire protection devices. School yards frequently have play equipment, flag poles, shaded and unshaded areas, and varying kinds of vegetation.

Near schools there are often parks, gardens, vacant lots, and fields where plants can be studied. Where there are plants there are insects and other animals. Near schools there are sometimes automobile service stations, stores, greenhouses, and other business establishments. These present many opportunities for the study of science.

Field work should be planned carefully. Children should know what they are to look for. Do crocus blooms stay closed on cloudy mornings? How is air put in a tire? These are simple, direct problems well fitted for field investigations.

Outdoor experiments make good subjects for field work. The pupils may compare the temperatures of pans of water in sunshine and in shade. They may study the effect of sprinkling water on a pile of soil.

Field work should be planned carefully. Children should know to do with his hands. The children may collect coloured leaves. They may take the temperatures of the soil in different places. They may write the answers to questions formulated before the trip.

Techniques for handling pupils in the field are somewhat different from handling pupils in the classroom. Each pupil must have something to do and he must know exactly how to do it. One of the important differences between indoor and outdoor situations concerns the amount of talking by the teacher. Lecturing and class discussion usually fail in the field because there are so many distracting elements. These techniques should be reserved for the preparatory and follow-up lessons. Once in the field, the teacher should generally talk only with individual pupils who come up with special questions.

Science Projects

Science projects exist in such rich variety that it is possible to appeal to the many interests and talents in a class. Children who like to work with tools enjoy making models. Children who like to draw and paint enjoy making posters, charts, and friezes. Children who like to write find opportunities to write stories and plays. Children who like to collect will enjoy preparing exhibits of their science collections.

Science projects such as these encourage pupils to plan, to use ingenuity, to persist at a job until it is done. Group projects give children opportunities to work together, to share, to assume leadership. The final products are tangible evidence of accomplishment and give the children deep satisfaction.

Such projects are important in the learning process. They bring together information and organize it in easily understood patterns. Often the projects give rise to new problems for the pupils to work on.

Completed projects should be put on exhibition whenever possible. Projects may be displayed in the foyer of the school, at Parents' Nights, and at P.T.A. meetings. They may be exhibited in store windows during Education Week. Local newspapers are usually delighted to publish photographs of exhibits and the children who made them; the teacher need only call up the editor and notify him of the displays. Through projects of this kind, parents gain a better understanding of what goes on in the school programme, and children enjoy sharing their science experiences with them.

CONSERVATION EDUCATION

Elementary science should make significant contributions to conservation education. Science deals with plants and animals, rocks, soil and water, and with the scientific principles that control these natural features. Science helps to meet the three general objectives of conservation education—1) to give information about natural resources, 2) to develop desirable attitudes towards the use of natural resources, and 3) to give experiences with conservation practices.

Studies of the life histories of living things give an understanding of their problems. Each book of the Exploring Science Series includes a number of life history studies, and others are suggested in the Teachers' Editions.

Interrelationships among plants, animals, and their natural environments are also important. Better understanding of interrelationships would have prevented the admission of many animal and plant pests into this country, the extinction or near extinction of many species, and the many other mistakes we have made in handling our environment. This Series stresses interrelationships in all units dealing with the natural environment.

In general, when pupils gain sufficient backgrounds of information they develop proper attitudes. Having seen a badly eroded pasture, having learned the value of topsoil and the difficulty of replacing it, they recognize the waste and the need for conservation practice. They need no indoctrination; they draw their own conclusions from the facts.

These books also show children how to practise conservation for themselves. They are encouraged to take care of their clothing and their toys. They learn to conserve heat by closing doors and windows in cold weather. They are instructed in the prevention of grass fires and forest fires. They learn how to co-operate in fire prevention about the home.

Children are also encouraged to help to keep streets, roadsides, parks, and picnic grounds free from litter. Much education is needed in the proper use of one of our great resources, the beauty of the countryside. By taking pupils to places that are beautiful and then for contrast to places that have been abused, the teacher gives them training in an important area of conservation education.

HEALTH AND SAFETY EDUCATION

All areas of the elementary school curriculum must share in the responsibility for helping children to learn to take care of themselves. Science is especially important since it contributes much of the informational background necessary. By broadening its goals, the teacher may use science as the basis for the health and safety programme when classroom time does not allow for two separate programmes.

These are the areas commonly included in health and safety programmes for the elementary school:

The meaning of health
Body growth and development
Nutrition
Circulation and respiration
Digestion
Elimination
Bones (including teeth) and muscles
Skin, hair, and nails
The senses
Ears, nose, and throat
Rest and relaxation
Mental health
Sanitation
Communicable diseases and their prevention

Tobacco, alcohol, and drugs
Preventing falls
Safety with tools
Preventing fires
Traffic safety
Treatment of small wounds
Prevention of sunburn
Water safety
Safety with animals
Safety with electricity (including lightning)

The Exploring Science Series provides a combined science and health programme when such a combination is desired. Most of the units in each book contain health and safety material. For instance, the fourth grade unit "Static Electricity" includes a lesson on safety during a thunderstorm. The sixth grade unit "Water in the Ground" includes several lessons on safe drinking water. In addition, each book contains one or more units dealing primarily with health and safety, which are noted at the end of each book under "The Major Topics Presented in Each Unit." Thus, a complete integration of the two programmes can be carried out in a completely natural way.

The flexible organization of the books permits the emphasis to vary according to need. If the school provides a separate health and safety programme, only a minimum amount of time need be spent on repetitious material in this Series. But if the combined programme is in operation, the health and safety material may be expanded as desired. The special helps in the Teachers' Editions show how to make the most of situations that arise from working with the Exploring Science Series.

It should be remembered that the science programme cannot assume the complete responsibility for health and safety education. Health and safety instruction must go on at all times. Children need orientation in the use of drinking fountains, public toilets, and school washrooms. They must be reminded constantly about washing after playing with things that dirty their hands, after going to the toilet, and before eating. They must be encouraged to play actively and then rest quietly. Safety in the classroom and on the playground must be stressed constantly. And the whole problem of mental health—good social adjustment, self-confidence, self-reliance—should be an every-minute-of-the-day concern of the teacher.

Detailed Teaching Suggestions for Book Three

There is no problem in interesting third-grade boys and girls in the science programme that is based on the study of familiar things and that provides plenty of exciting activities for them. There is more of a problem in turning their attention away from science towards other areas of the curriculum.

Together with other children in the lower elementary grades, third-grade children have far more aptitude for science than is ordinarily recognized. Their thinking is surprisingly mature and there is never any excuse for talking down to them. Indeed, there is some danger that a teacher will not recognize their clear thinking and will muddle them by introducing unwarranted generalizations and unjustified statements.

The teacher will find that in science she can treat third-grade children much as she would treat far older boys and girls, remembering only the more limited experience background of the former. Third-grade boys and girls are not ready to carry on extended discussions or to interpret much of what may be read or told them. A science programme for this level should consist chiefly of direct learning situations.

It is well to consider that the primary aim of elementary science is the development of a sound experience background. Discussions, reading, and telling should be limited and should be used chiefly to supplement information that has been gained at first hand. This means that beginning science should be taught as an activity programme in which there is full freedom to experiment, to construct, and to follow up special interests.

Pupils should be encouraged to repeat activities several times, improvising variations to test different conditions when possible. Delayed judgment and repeated testing form the heart of the scientific method. Pupils should be discouraged from drawing conclusions from a single observation. Teachers sometimes become impatient and hurry pupils into making broad statements. Remember that the development of proper thinking habits requires time and that such habits are more valuable than large amounts of poorly understood subject matter.

Verbalization is of secondary importance in the science programme. It is more important for pupils to have had an experience than to be able to talk about it. None the less, many third-grade pupils will be ready to express themselves clearly about their experiences. Some of them pick up scientific terms with surprising ease. It is not unusual for boys and girls on this level to talk fluently about "convection currents" and "the germination of seeds." One should realize that children pick up these words quickly only after they have an understanding of what the words represent. There should be no pressure on them to use words for which they are not ready.

Book Three of the Exploring Science Series uses relatively few scientific terms and these are introduced with great care. Scientific terms should be made part of the speaking vocabulary before being introduced into the reading vocabulary. This Teachers' Edition gives suggestions for introducing scientific terms when needed and desirable. Later books in the Series will make use of words introduced into both the speaking and reading vocabularies at this level.

All pupils may use these texts as learning guides without being handicapped by the mechanics of reading. The reading level of *Exploring Science Three* has been kept well below that of standard third-grade readers. The vocabulary has been checked against standard word lists. Sentences are short and direct, and paragraphs are brief. The majority of sentences which are longer than one line have been broken according to the natural divisions between phrases. There are, however, 23 pages on which the phrases themselves have been broken, offering a transition into Book Four which uses regular paragraphing. The 276 new words are listed below in the Word List in order of their first occurrence. Variants and inflected forms of words introduced in earlier books of this Series have not been considered as new words.

The Word List includes ten starred words which represent the special science vocabulary introduced and developed in the reading vocabulary of *Exploring Science Three*. For emphasis, each of these words has been set in bold-face type the first time it occurs in the text.

Many third-grade pupils are well above the average in reading ability. For them one should provide some of the growing wealth of fascinating science books and readers being written for children. The bibliographies at the ends of the units in this Teachers' Edition include some of these books. It is well to provide books of varied degrees of reading difficulty so that each child will have opportunities to read on his own level.

WORD LIST

5 games
brown
burns

6 hour
later

8 pets

9 dog

11 bulbs

12 supper

14 toward
dark

16 rise
set

17 any

18 rainbow

20 six
eight

21 five

22 squirrels
acorns
nuts

23 streams
miles
land
lily
away
bottom

24 maple

26 Peggy
dandelion
blew

27 travel
scatter

28 collect
woollen
drag
weeds

30 pods
sweet
pea

31 once
bare
lot
field

34 megaphone
thin
cardboard

35 talk
friends

37 horses
cats

38 wax
eardrum

39 aids

40 unlike

42 echo
hits

43 thunder
lightning

44 table
louder

45 tin-can
telephone
knots

46 fork

48 fire

50 fresh

51 stop

52 began

53 wrapped
rug

54 jack-o'-lantern
pumpkin

55 smokes

56 chimneys

58 stoves
furnaces
want

60 kill
start
order

62 teeth
born
months
afterwards

63 below

64 second
seven
while
jaw
ready

65 person

66 tongue

68 bobcats

69 beavers

70 healthy
milk
quart
meat
vegetables
agree
cake
pie
candy

71 brush
twice
bed

72 tooth
soft

76 Don
took
tracks
wonder
hind
feet
hops
sat
tail

77 ate
blackberry
whispered
shouted

78 thought
climb

79 led
bits
smell
remembered
trunk

80 cow
lying
scared

81 followed
fence

82 crows
dead
almost

83 woodpecker
bill
cracks
sparrows

84 quiet
raccoon
hollow
skunk
woodchuck

85 wake

86 toads
frogs
snakes
turtles

87 die
autumn

88 pond

89 bee
hives
honey

92 country
spend

94 *evaporates

95 damp
level

96 pour
amount
spilled

97 less
*vapour

98 *dew

99 *condenses

101 heat
teakettle
rapidly
tiny

102 cellophane
bag

104 *frost
freezing

106 bright
gray

107 clear

109 *fog

111 thick
safe

112 instead
formed

114 *energy

116 clock

117 stored
mouse
trap
screen

121 paddle

122 slip
tack

126 thumb-tacks

128 gasoline

130 filings
*magnetic

131 tap
gather

132 balance

133 ruler

134 stroke

136 thread
fold
bar

137 cork
dish

138 north
south

139 compass

142 horseshoe

143 twist
spin

144 rock
lodestone

146 handful
shake
still

147 ploughed
gully

148 sprinkle

151 fifteen

152 washes
loose

156 brook
helpful
harmful

158 stir
lake

160 *male
pools
puff
throats
trilling

161 *female
jelly

162 tadpoles

164 gills

168 catch
swallows

169 taste
mind

172 pads

174 fishworms

176 important

177 lawn
also

178 young
wheat

179 towel
grains
between

181 shears
mower

182 only
rye
flour
bread
barley
soup

183 oats
pounding
meal

184 ago
flat
crush
grind
fine

185 sift
bran
whole

186 wild

187 meadow
dinner

188 fed

Sunshine

PURPOSE OF THE UNIT

An understanding that the earth receives its energy from the sun is one of the major concepts of science. It is not an easy concept to grasp; mankind needed thousands of years to develop our present understandings. A person must have hundreds of experiences with heat, with light, with growing plants, and with other factors of our environment to begin to appreciate what the sun means to us. As teachers we should build carefully, giving children experience after experience, developing the simple concepts upon which general principles are based, and never hurrying the children into verbalizing before they are ready.

This unit deals with a few simple, but basic, concepts—that we receive heat from sunlight, that certain plants need sunlight, and that more sunlight comes to us in the summer months. It is part of a broad area dealing with energy and with energy changes. Specifically, it is part of the sequence in this Series on light. It follows up first-grade work with light in "Watching the Flag," and second-grade work with light in "Watching the Sky," and "Mirrors." Upon this unit will be built such units as "A Hand Lens," "Rainbow Colours," and "Our Eyes" in later grades.

This unit is also part of the astronomy sequence. It continues the experiences initiated in the first-grade units, "Watching the Flag," and "Rain," and in the second-grade unit, "Watching the Sky." Later units that build on it are "Night Comes," "The Winter Sky," and "Time and Seasons."

This unit will add a few more experiences to the many that have already been given in the areas of plant and animal behaviour. However, the children have not yet had enough experiences to make major generalizations. They should still talk in terms of specific plants and animals.

A few introductory experiences with plant-light relations are given at this time, two years before the unit "Plants and Light" is introduced. By calling attention to the differences in the colours of plants developing in light and in darkness, children are encouraged to notice similar instances outside of school. They will thus have a better background of experience on which to base the study of food-making by green plants.

We should always be trying to provide such an interaction between in-school and out-of-school experiences. In-school experiences should be built upon out-of-school experiences whenever possible, and in their turn they should give meaning to fresh out-of-school experiences. So the interaction continues, building up like a snowball rolling down a hill.

PREPARING FOR THE UNIT

A unit as general as this one may be studied at any time of the year. It has been assigned an early place in the book because this placement gives the teacher more opportunity for extended follow-up.

A few materials are needed for the experiments. Geraniums can be used to show the growth of leaves towards the light. Narcissus bulbs can be used for the experiment concerning light and the colour of plants. At least two thermometers are needed and more if possible so that greater individual participation is encouraged. The demonstration explaining moonlight calls for a strong flashlight or a slide projector.

List of Materials

2 Metal pans
2 Wall thermometers
Sand
2 Geraniums or other house plants
2 Bulbs—narcissus or onion
2 Pots for the bulbs
1 White ball (a tennis ball)
1 Flashlight or slide projector

TEACHING THE UNIT

The unit is flexible. Its separate topics may be taught in any order. Some topics may be delayed until conditions are especially favourable. The section on the moon (pages 14–16), for instance, could well be taken up at a later time.

The word "temperature" was introduced in the second-grade unit, "The Thermometer," but it may be well to re-introduce it carefully. It is not usually in the reading vocabulary of children at this level. The word "reflect" was introduced in the second-grade unit, "Mirrors." It, too, may need re-introduction.

Pages 4–5

The beach scene is a means of recalling experiences with sunshine during the summer months. Typical questions are: **Have you ever been at the beach? When did you go? Tell about the things you did.**

How does the sun feel when you are at the beach? If you went now would it feel the same? How would it be different? Did the sand feel hot then? Was the water hot? How would the sand feel now? How would the water feel?

What happens if you stay out in the sun too long the first time you go out in the spring? How can you keep from being sunburned? Notice the girl sitting under the umbrella.

Discuss with the children the effect of sunshine on the skin—tanning, sunburn, and the healthfulness of a moderate amount of sunlight. (One of the most conspicuous differences between two races of people is the skin colour, but this is actually one of degree, there being no distinct division between any two races.) **Why does the boy in the picture have his arm over his eyes? Why do people wear dark glasses?** Stress the fact that people should never look directly at the sun even with dark glasses on.

If the children have never been to the beach, ask them to recall other experiences they have had in sunlight. Many of the same points can be discussed: how to avoid sunburn; how to care for the eyes; and how hot rocks, soil, and metal may become in sunlight.

Pages 6–7

These experiments are to be done by the pupils. If the unit has been delayed until winter, one of the pans may be set on a sunny window-sill to show the heating effect of sunlight.

In the description of these experiments nothing has been said about using equal quantities of sand and water in the two pans. Although in these particular experiments results are not dependent upon quantities unless the quantities vary greatly, the pupils should be thinking in terms of keeping as many factors equal as possible. Encourage them to discuss their plans for the experiments before doing them. See that the problem of quantities is raised.

In addition to the suggested experiments, the pupils may check temperatures at noon and at home during the evening. This should be done for several days to see if there is a constant variation. Some of the children may study the newspaper records of temperatures and report on these to the class.

Pages 8–9

These pages call attention to the reaction of animals to sunshine. Some animals, like the garter snake and painted turtles, like to bask in the sun; some, like the Holstein cow, try to avoid it on hot days. Ask the children to describe their own observations and encourage them to make more.

Certain pupils may know about animals that seem to prefer darkness to daylight. They may have seen bats, night-flying insects, and possibly owls. Ask them to tell about their observations and repeat what they have heard from others.

Pages 10–11

Some children may have discovered already that the leaves of house plants turn towards the light. Be sure to try the experiment, however, so that every pupil has a chance to see what happens. (Page 10 shows geranium plants; page 11, narcissus bulbs.)

Take the children outdoors to look for limbs of trees that die because they are continuously shaded. Show them how the leaves of vines on buildings grow so that very few leaves are shaded by others. Pull up rosettes of dandelions or plantains in a lawn to show that grass cannot live under the rosettes. Look under low shrubs to note whether grass grows there.

Children may have noticed the colour of grass that has been under a board for some time. They may try laying a board on the grass and then looking under it several days later; this experiment works best in spring when grass is growing rapidly.

Pages 12–13

These are discussion pages. The questions help the pupils to contrast summer and winter by asking them to remember how the difference in the amount of daylight affects their activities. Besides the difference in their activities, they can discuss the use of electricity in their homes, the times when street lights are turned on, and the use of headlights on automobiles in summer and winter.

Pages 14–15–16

These pages introduce the understanding that moonlight is reflected sunlight. From their work with mirrors in the second grade the children should have grasped the concept of reflection which they can now apply to the moon.

For the demonstration that is suggested, a darkened room is needed. If the classroom cannot be darkened enough, take the class to some other room, such as one where slides are shown. Failing this, it is often possible to wait for a dull, rainy day when, with shades drawn, the room is dark enough for the demonstration. Use a white ball.

To help the children to understand the concept of reflection more clearly, encourage them to take a white ball into a perfectly dark place such as a closet at night. They will not be able to see the ball. Then as they open the closet door and let a little light enter, the ball becomes visible. If the light is not very strong the ball will resemble the moon.

Encourage the children to make nightly observations of the moon and to make drawings of the shapes that they see. They may not be able to understand the cause for the changed shape, but if some children are interested the teacher may repeat the demonstration on page 15, calling attention to the change in the visible portion of the lighted area as the ball is moved round the source of light.

The landscape diagram at the top of page 16 assumes that the observer is facing south. An observer in the northern hemisphere would have to be facing south in order to watch the east-to-west movement of the moon or of the sun. Help the children to orient the page by having them face south (toward the sun at noon) after which they can point toward the east (on the left) and toward the west (on the right). Other diagrams in the Exploring Science Series showing movement of the sun and moon are the same: the observer faces south, and east is on the left.

Page 17

This is a summary page that helps the children to understand that the sun is a source of much of the light that we see. In Picture 1, the sun has lighted the objects around us. In Number 2, it lights the sky and the clouds but not the things around us directly. In Number 3, it lights the moon but not the earth and the clouds. In Number 4, the sunlight does not fall on anything we can see and the night is very dark.

Page 18

This page introduces the concept that sunlight is not just light but is made up of many colours. This idea will be expanded in the fifth-grade unit "Rainbow Colours."

Besides using a rectangular aquarium full of water, a glass prism may be held in sunlight. The rainbow colours will appear on the ceiling. Ask the children where else they have seen rainbow colours like these.

Some children may want to know where the rainbow colours come from. Although this subject will be taken up in more detail in the fifth-grade unit "Rainbow Colours," it may be explained that sunlight is made up of many colours. This idea will be expanded in the fifth-these colours.

Summary Questions

1. The children may name the animals shown on page 8 and others that they have seen lying in sunshine.
2. The children should know about sunburn and how to avoid it.
3. We receive our greatest amount of sunshine in late June. The children will probably mention summer as being the season of most sunshine although we receive as much in the spring. The discussion would need to be rather technical to make the reasons clear. It seems better to accept the answer "summer."
4. Pages 14, 15, and 16 told the children that we believe moonlight is reflected sunlight without giving reasons for our belief. See if the children recognize this limitation to the statement.
5. The children may describe the experiment with the narcissus bulbs and any other observations they may have made. Do not forget, however, that the great group of non-green plants, most of them fungi, do not need light. The children should not be compelled to generalize on this subject.
6. The experiments will have shown that sunshine heats water and sand. Ask the children to describe other observations that back up their statements about the heating effects.

Follow-up

This is not a unit to be studied and then dropped. The follow-up should go on all year. Some of the experiments may be repeated at different seasons. The children should be encouraged to watch their pets seek or avoid sunshine, and they should watch the growth of plants in the schoolroom and at home. When potatoes, carrots, and other vegetables begin to sprout in late winter some of these should be brought in and allowed to grow in a dark place to see what happens to their colour.

As the days grow shorter, the children should be conscious of the decreased hours of sunshine. A few minutes can be taken from Christmas preparations to call attention to the shortest day. As spring comes, the children should notice the lengthened days and the teacher should point out the time when day and night are equal, and the time when the daylight hours are longest.

The study of the moon needs extensive follow-up. Pupils should note the changes in its shape, the direction of the moon's motion across the sky, and the variation in the time when the moon can be seen. When the moon is visible in the afternoon and in the morning, as it is a few times each month, the teacher may point it out to the pupils.

POSSIBLE LEARNINGS

Sunshine heats many things it falls on.
Some plants need light.
Many people like sunshine, but too much sunshine may burn the skin.
We have more hours of sunshine at some seasons than at others.
The moon is like a large ball in space.
Moonlight is reflected sunlight.
Sunlight sometimes changes into the rainbow colours.

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Books

Follow the Sunset. Herman and Nina Schneider. Doubleday: Toronto, 1952. 43 pages.
A trip round the world with the sun.

How Big Is Big? Herman and Nina Schneider. S. J. Reginald Saunders: Toronto, 1950. 50 pages.
Develops ideas of sun in simple language, with good illustrations.

How the Sun Helps Us. Glenn Blough and Ida De Pencier. Copp Clark: Toronto, 1953. 35 pages.
Stories for the primary grades about the sun and its powers. Illustrated.

The Sun. Herbert S. Zim. George J. McLeod: Toronto, 1953. 72 pages. A well-illustrated book with many diagrams and experiments. Good for teachers and for children 3–6.

Film

Light and Heat. Gateway.
Sources of light, heat accompanying light, and what light and heat do for us, presented simply for primary-grade children.

Travelling Seeds

PURPOSE OF THE UNIT

This unit on seed dispersal is part of a sequence on plant reproduction. It builds on the first-grade unit "Planting Seeds" and on concepts given in the second-grade unit "Buds." Units in later grades, namely, "Growing Plants Indoors," "Flowers and Their Work," and "Plants That Are Not Green," continue to extend the understanding of how new plants are produced.

This unit stresses the relations among plants, animals, and the physical environment. It establishes concepts important to the understanding of plant distribution. Because seeds are a part of the diet of so many animals, the material of this unit furnishes a background for many units on animal study.

An interest in seed dispersal gives pupils things to look for when they are outdoors. This interest encourages them to go outdoors more and to observe what is around them. The habit of observing is among the goals of every good science programme.

PREPARING FOR THE UNIT

It is recommended that this unit be taught in early autumn. It is then that one can find the widest variety of seed-distribution methods.

Before introducing the unit, a teacher should look in the vicinity of the school for places where there are many weeds. Roadsides, unmowed meadows, vacant lots, neglected gardens—all produce plants which are of little economic value but which are very helpful to teachers.

It is also a good plan to collect through the year generous samples of such seeds as elm seeds that are produced at times when this unit is not taught. These seeds may be dried and stored in glass jars or small boxes.

It is helpful to have glass vials and bottles in which to display seeds. Cellophane envelopes are also useful.

List of Materials

Large pan
Pane of glass to cover the pan
Spade or spading fork
Seeds
Bottles and glass vials
Hand lenses

TEACHING THE UNIT

A unit of this type is enriched by field trips. Around every school there are places where plants have appeared as the result of some form of seed dispersal. Each one of these instances presents a problem for the children to solve. When the fruits of the plants are known, the children can guess at the means by which the plants came to the locality.

The word "fruit" needs some explanation. In common usage the word is applied to such things as apples and blackberries, but not to pumpkins and tomatoes. Actually these are all fruits, together with many other things that are not called "fruits," such as the winged fruits of maples and the hooked fruits of burdocks. A discussion of "What is a fruit?" is too technical for young children, but in the case of tomatoes and watermelons the children quickly recognize similarities and accept the classification.

Page 19

To open the unit, one may bring in fruits that illustrate an interesting method of seed dispersal. Children like to play with milkweed down and with the winged seeds of maples. After the children have experimented with the seeds, the discussion may lead into the advantages to the plant of such features.

The title page of the unit sets up a problem. **How did the berry bush** (raspberry) **come to grow in the crotch of the** (sugar maple) **tree?** This is a sight common wherever old trees line streets and fields. The novelty of seeing one plant growing in another appeals to children.

There may be other situations of a similar nature near the school. Plants sometimes grow on top of a rock, in a stone pile, and even on the roof of a neglected house. A trip to see such a phenomenon helps to set up a problem in the minds of the pupils.

Pages 20–21

These pages take up the distribution of the seeds of edible fruits. First there is a picture story to be read by the pupils and told in their own words. The children may then discuss the location of wild fruit trees in the neighbourhood; such trees are often found in vacant lots and along hedgerows. The story of Johnny Appleseed may be read to the pupils at this time.

Page 21 reviews and builds on some of the concepts developed in Books One and Two. Children should be encouraged to bring in fruits to be cut open—apples, pears, peaches, plums, grapes, late varieties of berries, oranges, lemons, and the like. The children may clean the seeds of these fruits, enclose them in vials, and mount them with pictures or drawings of the fruit.

The children may wish to plant some of these seeds. They must not expect complete success because many seeds must lie in a cool, damp place for some time before the young plants inside are able to grow. However, orange and lemon seeds will germinate quickly in a pot of moist soil.

Page 22

This page deals with the distribution of acorns and other nuts. Squirrels, after collecting and burying these foods for winter, frequently fail to dig them up again.

The pupils should be encouraged to bring in nuts (and acorns) for the seed collection. They may open a few of these to see the edible portion inside.

If there are oak trees or nut trees in the vicinity, take the children to collect the nuts, which may be dried and eaten later in the year.

The fruits of many other plants are eaten by animals and the seeds are thus carried long distances. Birds such as robins carry the seeds of cherries and berries. Many mammals feed extensively on fruits—foxes, bears, and skunks make fruits the principal part of their diet in season. Seeds of such fruits pass through the digestive system of the animal without being affected.

Children may wish to plant seeds of the fruits they bring in. Remind them—many seeds must undergo a quiet "ripening" period before they germinate. Nuts (and acorns) must be stored in a cold, damp place, or buried in the ground until spring. Explain this so that the children are not disappointed when their seeds do not grow.

Page 23

This page needs no explanation. The children may have seen seeds floating on a stream or lake. They may also find them by examining the debris cast up along the shore by the current or waves. They may plant some of these seeds to see what plants grow from them.

Pages 24–25

Fruits with wings are interesting to children. Many of the plants that bear these fruits do so early in the season, but there are usually some available in the fall. Winged seeds collected earlier in the year can be experimented with at this time.

The activity shown at the top of page 24 provides an experience basis for understanding the distribution of this type of fruit. Maple fruits are shown.

Other winged fruits are shown at the bottom of the page. Ask the children to bring in the cones of evergreen trees. Show them how to locate the winged seeds by pulling off the scales of the cones. Encourage the pupils to collect other kinds of winged seeds and add them to the collection.

Page 25 suggests an experiment which aids in an understanding of the role of the wind in seed dispersal. On a windy day equal quantities of winged seeds are dropped at the same time from two different elevations. Ask the children which go farther. **Would winged seeds be scattered farther from tall plants or low plants? On which kind do we usually find them?**

Although a step-ladder is shown in the picture the fruits may be dropped from a window, a slide, a saw-horse, or from any other elevation. Always discuss with the pupils what precautions they should take against falling.

Pages 26–27

These pages mention fruits that may be compared with parachutes. Most children have played with the seeds of dandelions and milkweed. Such experiences may be repeated.

A trip to gather milkweed pods is always interesting. The pods should be opened and studied, and then when the down has dried, the seeds may be blown about.

The tumbleweed shown at the bottom of the page blows about when the plant has died and the top has become dry. There are several kinds of plants that are "tumbleweeds." One may see them rolling about on windy days in winter.

Pages 28–29

Stick-tight fruits are well known to anyone who walks or plays in a neglected field. After a short walk in autumn one can usually find the beginnings of a collection on his own clothing.

The plant in the picture story is a burdock but it might well be any of a dozen plants. After the children have read and discussed the story ask them if anyone has seen a dog pulling "stick-tights" from its hair. Ask how he does it and what happens to the "stick-tights."

The top of page 29 suggests a method for gathering "stick-tight" seeds. Rough woollen cloth is the best material for gathering these "stick-tights."

To help the children to see how "stick-tights" are able to cling so tenaciously to hair and clothing, give them hand lenses with which to see the various hooks and barbs on the seeds.

Page 30

Fruits that throw their seeds are less well known to children. All the plants shown are common in various sections of the country, but people do not notice their method of seed dispersal. Besides the ones shown, there is a relative of the jewelweed, called garden balsam, that is often raised in flower beds. Perhaps the children have seen its fruits burst open.

Pods of perennial sweet peas are especially good for study. When the pods have yellowed and partly dried, bring to school some of the vines bearing them. Hang the vines up. In a short time, the pods will become dry and burst open, showering their seeds around the classroom.

Twigs of witch hazel, too, when brought into the classroom, will throw their seeds great distances as the pods dry and burst open.

Page 31

This page shows two places that have been invaded by new plants. **What plants can you recognize? By what means may the plants have come to the places where they are growing?** Use these pages as a review of the commoner means of seed dispersal. Visits to similar places will provide more opportunities for application and review.

Page 32

This instructive activity demonstrates the amazing numbers of seeds that are in the ground at all times. Little attention need be given the soil except to keep it from drying out. A glass pane over the top helps to hold the moisture. If the soil becomes dry, sprinkle it until it is damp again but do not put in so much water that the soil is soaked; seeds will rot if kept warm and wet.

Depending upon facilities, the teacher may extend this experience by using soil from different localities—gardens, woods, meadows, marshes, swamps. These different soils will produce different plants. Some of the plants will be familiar to the pupils; some will be utterly unfamiliar in the seedling stage.

Summary Questions

1. In general terms, squirrels scatter nuts. However, if possible, ask the children to name specific nuts with which they are acquainted, such as acorns, hickory nuts, or black walnuts, depending upon what grows in the region.
2. After the children have mentioned "stick-tights" see if they can name specific kinds such as burdocks.
3. The answers to this are the same as those for the preceding question.
4. The children should be able to describe how the wind picks up a dandelion seed by its "parachute" of down and carries it along.
5. Children should be able to describe how the wings keep the seed from falling rapidly, thus giving the wind a chance to carry it farther.
6. The children should be able to describe how some plants throw their seeds, and how some seeds are carried by water. They should also be able to give examples of each method.

Follow-up

Interest in seed dispersal often continues throughout the year. As new kinds are seen on trips, the children should bring them back to school to add to the collection. The pupils should also be encouraged to keep alert for new kinds they might see when out by themselves.

POSSIBLE LEARNINGS

There are seeds inside fruits.
Animals help some kinds of plants by scattering the seeds.
Wind and water carry the seeds of many kinds of plants.
Plants move into new areas as their seeds are scattered.

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Anywhere in the World. Irma Webber, S. J. Reginald Saunders: Toronto, 1947. 64 pages.

Gives children the idea of how plants adapt themselves to climate and natural conditions. Well illustrated.

Audubon Nature Bulletins. Prepared and published by the National Audubon Society, New York. 4 pages each.

Several of the bulletins contain background information to supplement this unit. List sent by the Society on request.

Handbook of Nature Study. Anna Botsford Comstock. Thomas Allen: Toronto, 1947 ed.

Valuable for general reference and as a teaching guide. An up-to-date natural history library in one volume.

Play with Plants. Millicent Selsam. George J. McLeod: Toronto, 1949. 62 pages.

Experiments with plants.

Seeds and Seed Travelers. Bertha Parker. Copp Clark: Toronto, 1941. 34 pages.

Defines types, experiments, the functions of seeds and how they are distributed.

Travelers All. Irma Webber. S. J. Reginald Saunders: Toronto, 1937. 32 pages.

An excellent and simple introduction to plants and their seeds. Well illustrated.

Films

SN-68 Seed Dispersal. Ontario Department of Education.

Portrays the dispersal of seeds by wind, animals, and self-propulsion.

SN-139 Wonders of Plant Growth. Ontario Department of Education.

Children grow plants from bean and squash seeds, the stem of a geranium, the leaf of a succulent, and the root of a sweet potato plant.

Hearing Sounds

PURPOSE OF THE UNIT

In the rich realm of sounds around us—the song of birds, the fiddlings of insects, the mating calls of toads and frogs, the whispering of leaves and grasses—some people live unheeding and unhearing. It is not because their senses are dull, but rather because their senses are untrained. The purpose of this unit is to awaken an awareness of sounds. But these printed pages can do no more than set the stage, the rest depends upon the interest and enthusiasm of the teacher.

The mechanics of sound do not concern us at this level. We are laying a foundation of experiences with echoes, the speed of sound, and the transmission of sound. These are not only valuable in themselves, but also fundamental to later study of the physics of sound.

We will touch upon, but not go deeply into, the anatomy of our ears. At this time our interest in this subject is mainly in promoting safety and health practices to protect pupils' hearing.

PREPARING FOR THE UNIT

Before teaching this unit a teacher should look for opportunities to enrich the work suggested here. Perhaps there is a long metal railing that the children can use to discover that sound travels through metal. Perhaps a train whistle can be heard every day at a certain time.

Little equipment is needed. Sheets of Bristol board are needed for the megaphones. If possible, have enough so that each pupil can make his own megaphone.

For a tin-can telephone we need two metal cans with smooth edges and a length of strong twine such as fishline. For the "bell" described on page 46, we need a fork or a short length of pipe.

To enrich the study of the anatomy of the ear, a large model of an ear is helpful. Sometimes one may be borrowed from a biology or health teacher.

List of Materials

Scissors
Bristol board
Paper fasteners
String
Metal cans or Dixie cups
Fork or short piece of pipe
Old pail or pan

TEACHING THE UNIT

The best approach to the unit is the use of some natural situation that depends upon local conditions. When a train whistle blows, the pupils can be asked what causes the sound and how they know a train is coming. Similar questions can be asked about airplanes, automobiles, and the like. The children may be asked to shut their eyes and describe what they know is happening because they can hear sounds.

Page 33

This page suggests some things that can be identified by sound. Ask the pupils to listen and see if they can hear any of these things outside the school. Open the windows if necessary.

Ask the pupils to try to imitate some of these sounds. Make this activity into a guessing game if desired.

Page 34

If possible, give each pupil enough material to make his own megaphone. This is a good lesson in following directions.

The pupils may need some help in cutting off the inner corner of the cardboard after the first cut has been made. Show them how to draw a pencil line along the first cut to mark the position of the second cut. The pupils should be able to push the paper fasteners through the Bristol board; if not, the teacher can start the holes with something sharp, such as the point of a knife.

Page 35

These experiments lead toward the idea that sounds can be directed by reflection, although one should not insist upon a verbalization of this concept. The experiments are best performed outdoors but may be performed indoors if necessary.

To enrich this work, show the children that the loudspeaker of a radio or phonograph is shaped something like a megaphone.

Page 36

This exercise is especially instructive and assists in many later activities. Using a large megaphone, one may hear faint whispers with amazing clarity. Other sources of sounds may be used such as the dropping of pins and the snapping of fingers. Open the windows and let the children listen to outdoor noises. The possibilities for individual experimentation are almost endless, and one should not hurry through this work.

Page 37

The idea that outer ears collect and direct sounds into our heads is a new one to most children. It is, however, but one step from the experiments with the megaphone to the study of the outer ear. The children should study and discuss the behaviour of the horse as it listens to faint sounds from different directions.

Children may not have an opportunity to observe the ears of horses but they can watch the ears of their pets. Sometimes a tractable dog or cat can be brought into the classroom and, after it is relaxed and resting, its attention can be attracted by faint squeaking. Then the animal will prick up its ears. Cats may turn their ears; dogs usually turn their heads.

Page 38

For an understanding of the proper care of our ears we should know something of their anatomy, but we must keep the study simple at this grade level. Children can examine the outer ear and the opening of the canal. They can be told about the eardrum and shown its location on the diagram. It is doubtful whether they will benefit much from a study of the middle and inner sections of the ear.

Ask the children to look in the ears of others and compare them with the diagrams on this page. They can usually see the little hairs but they may not always see wax.

A large model of an ear will help the children to grasp the concept of the eardrum better than a picture or drawing alone.

Page 39

Because hearing aids are not too common, they tend to attract attention. Some people refuse to use them because they feel self-conscious. Actually, a hearing aid should be no more embarrassing than a pair of glasses. Perhaps if we can educate people properly they will stop denying themselves the pleasure of good hearing.

It may be possible to demonstrate a hearing aid to the class at this time. Compare the device with a telephone; point out the "transmitter" and the "receiver." Show the dry cell that activates it.

Some schools have a programme for testing hearing acuity. The tests may be given in conjunction with this portion of the unit.

Pages 40–41

The animals on these pages are to be compared with people in terms of hearing. Most mammals have ears closely resembling ours except for the shape of the outer ears. Moles and shrews, subterranean animals, have practically no outer ears; rabbits and bats, nocturnal animals, have relatively enormous ears.

Little is known about the hearing mechanisms of non-vertebrates. Certain organs rich in nerve endings are present in many insects, and it seems likely that these organs are used in hearing. Crickets have such organs on their front legs, grasshoppers have them on the sides of the thorax.

Pages 42–43

Any large building will usually help to produce an echo if one can stand a few hundred yards from it. A variation of the experiment described in the text can be carried out if there is room enough. Move the class farther and farther from the building and note the increased time needed for the echo in each case. Then return toward the building and note the decreased time.

To produce echoes one may shout or use noise-making devices of other kinds. Two boards slapped together make a short, intense noise that is useful for this experiment.

In some localities cliffs and steep hillsides help to produce echoes. Teachers should take advantage of these resources.

Large empty rooms are often characterized by echoes unless there are provisions made for reducing them.

Page 43

The concept that sound needs time to travel serves as a basis for many interesting observations. The experiment described on this page is simple but none the less effective in developing this concept.

For success, one needs a large field such as a baseball diamond or football field, or an open area in a park. The day should be windless and reasonably quiet. Instruct the child who beats the pan to raise his stick high over his head, bring it down rapidly against the pan, and then return it as quickly to the position above his head again. Other noise-making devices may be tried if exaggerated motions can be used in producing the noises.

Sometimes a steam whistle can be seen at a distance. Have the children note the interval between the appearance of the steam and the hearing of the sound. A man chopping wood at a distance produces a similar effect.

A thunderstorm provides a spectacular application of this principle. One may note the changing interval between lightning flash and thunder as the storm approaches and passes away. Tell the children that the flash and sound are produced at the same time.

Pages 44–45–46

Many substances transmit sound. Air is the most important to us because we are surrounded by it. Most solids also transmit sounds and these pages describe a few activities that illustrate this fact.

A variation of the demonstration on page 44 uses a long board supported on the backs of two chairs. A watch placed on one end of the board can be heard easily through the wood but will be inaudible at the same distance through the air. One may also scratch the board with a fingernail and note that the sound through the wood is much louder than through the air.

The tin-can telephone is so well known that it needs no discussion here save to point out that the string should be kept tight and away from all objects along its path. In place of the tin cans the pupils may use paper cups.

The "bells" or "chimes" heard through a string are truly remarkable. In addition to the fork shown in the diagram on page 46, one may use a piece of pipe or a metal bar. Longer pieces give deeper tones. Each piece will have its own characteristic tones which are frequently as beautiful as cathedral bells.

A long piece of pipe or a metal railing can be used to show that metal conducts sound. Tap one end of the metal while the children take turns listening at the other end.

A long piece of garden hose can be used as a speaking tube. When one speaks into one end of the tube, the sound travels through the air in the tube to a listener at the other end.

Summary Questions

1. The children will probably recall the use of the megaphone or horn in the ear to make sounds seem louder. Some may say that we can turn our heads or cup our hands behind our ears. Some may suggest the use of a hearing aid.

2. A horse turns his ears to hear faint sounds better and also to determine the direction from which they come.

3. The children should be able to describe the eardrum and tell what may happen if a sharp object is inserted in the ear.

4. An echo is a reflected sound. When sound hits a wall it "bounces" back again.

5. The children can describe the experiment they carried out on page 43, they can describe an echo, or they can tell about thunder and lightning.

6. From the work of this unit, the children should know that air,

wood, and string carry sound. They may have had experiences which enable them to add other things to the list.

Follow-up

As stated before, the amount of work done in this unit depends upon the teacher. There is an almost endless variety of valuable experiences that can be given and it is to be hoped that teachers will continue to give them.

At various times the pupils may be asked to rest their heads on their arms for one minute and then they may be asked to identify the various sounds that they heard.

The phonograph and the tape recorder provide a wealth of possibilities for study of different sounds. The class may also listen to different musical instruments and try to identify them.

On trips in woods and fields it is interesting to stop and to identify as many sounds as possible.

POSSIBLE LEARNINGS

Sounds can be directed.
Sounds directed by horns into our ears seem louder.
Sounds travel through air, string, and wood.
Sound takes time to travel.
We can injure our ears by putting sharp things in them.

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The Quiet Noisy Book. Margaret W. Brown. Musson: Toronto, 1950. 34 pages.

About interesting sounds and things that are quiet or noisy.

Sound. Bertha Parker. Copp Clark: Toronto, 1944. 34 pages.

The elementary principles of sound that will be usable by the teacher.

Films

Hear Better; Healthy Ears. Coronet.

The process of hearing shown by animation; concludes with general information on the care of the ears.

What Is Sound? Young America Films.
Tom and his class perform may simple experiments with sound.

H-7 Your Ears. Ontario Department of Education.
The physiology of the ear explained in detail.

Fire and Air

PURPOSE OF THE UNIT

The study of fire is a phase of chemistry because fire involves, among other things, the union of elements to form new substances. We will not, of course, develop so advanced a concept at this level nor even mention such words as *oxygen, hydrogen,* or *carbon.* But we will be laying the groundwork of experiences on which the concept can be built in later grades.

This is the second unit involving oxidation, the first being the unit "Rust" in *Exploring Science Two.* We should not expect children to see the relationship between the two units and we must not try to force such an understanding. There will be later units that touch on fire and fire prevention. These units build directly on the present unit. In the junior high school, it is to be hoped that all related experiences can be drawn together in a study of oxidation.

"Fire and Air" is an important part of another sequence attempting to develop an appreciation of air as a substance. The first-grade unit "Air" and the second-grade unit "Wind," together with references to air in other units, begin this sequence. In *Exploring Science Four* a unit on "Airplanes" extends the understandings previously developed.

This unit also fits into a sequence dealing with heat which began with the first-grade unit "Signs of Winter" and the second-grade unit "The Thermometer," and continued with the third-grade unit "Sunshine." Later units on heating our homes and on winds will build on the understandings gained in the early part of the sequence.

While teaching this unit we should be thinking in terms of developing good safety habits. Children should learn to respect fire by knowing the good it can do and the damage it can do. They must know how they, as individuals, can keep from starting dangerous fires. They should know what to do if they discover a fire that is out of control.

In this respect, remember that children in the third grade should not attempt to fight fires; impress upon them the need for calling adults for help.

This unit is, in part, a conservation unit. Every fire in a home wipes out not only the building itself, but labour, metal ores, money, trees, and even irreplaceable soil materials that went into crops used in the construction of a home. Grass fires and forest fires wipe out, on a much greater scale, part of our national heritage. The job of our schools is to build understandings and attitudes that help to prevent this waste.

PREPARING FOR THE UNIT

This unit may well be taught in late fall when parents are starting fires at home in furnaces, stoves, and fireplaces. Experiences given at school can give new meaning to observations made at home. Much of the work can be done in connection with Fire Prevention Week. For equipment, the teacher needs only such simple things as candles, matches and glass jars. Incense sticks to produce a smoke are helpful. A fire extinguisher for safety's sake is a necessity, not because the activities involved are dangerous but because we want to impress upon the pupils the unceasing need for caution.

It is recommended that the suggested activities be carried out as class demonstrations. A teacher is able, in this way, to ensure careful handling of materials and proper precautions.

A teacher should be on the alert for places to which the children may be taken to see applications of some of the principles studied in this unit. Examples of such places are the school heating plant and any nearby homes that are heated by furnaces.

List of Materials

Candles
Glass jars (various sizes)
Matches
Short piece of wire
Pumpkin
Lamp chimney
Fire extinguisher

TEACHING THE UNIT

Much will be said in the following pages about letting the pupils repeat experiments a number of times. To be truly scientific we do not draw conclusions from a single observation or even from a few observations. We try to make as many observations as possible.

But as teachers who have made repeated observations ourselves, we tend to be impatient and to hurry the children into new areas before they are truly satisfied. Let us remember that developing habits of sound thinking takes time.

Page 47

This introductory page illustrates an experience common to most pupils. The picnic lunch laid out, the hot dogs ready to be roasted, and the balky fire giving off clouds of stinging smoke. Then someone blows lustily, fanning the smouldering sticks into a crackling flame.

Let the children discuss the picture and let them tell of their own experiences. Do not at this time anticipate the work of the unit by referring to the fire's need for air, but return to this picture later in the unit to rediscuss it in terms of the new understandings.

Page 48

This is one of the basic experiments in science. Before beginning it, show the pupils the precautions to be taken—the fire extinguisher, the place to strike the matches, the receptacle for the burned matches.

Ask a pupil to light the candle and ask another to set the jar over it. Show the first pupil how to light the match properly, scratching it away from himself, and insist that the burned match be disposed of suitably.

Note that the experiment is to be done several times under different conditions. It is important that the pupils refrain from drawing conclusions from a single observation.

Note also that this one experiment proves little. The only valid conclusion that can be drawn is that a candle will not continue to burn indefinitely in a closed glass jar. It does not prove that all fires need air in order to burn.

When repeating the experiment, give other children a chance to participate. Choose as many girls as boys, and do not let the more aggressive pupils dominate the work.

Page 49

This experiment, like the previous one, admits of only a limited generalization. Repeated several times, it proves that candles will burn longer in large containers than in small ones. A scientifically minded child might suggest that a fourth candle be left uncovered for comparison.

The technique to be used is simple. Three candles of equal size are attached to three cards respectively with a drop of melted wax. The candles are lighted and each of three children picks up a jar. On signal they invert the jars and put them over the candles as shown.

Page 50

This activity is best carried out by the teacher the first time and then it may be repeated by the pupils. Ask some questions to be sure the pupils are following the correct line of thinking. **What is in the jar in the first picture? Is there still air in the jar in the second picture? Is this air the same as it was before? Smell it. Is there air in the jar in the third and fourth pictures? Is it the same air as in the second picture?**

The jar may then be refilled with fresh air by first filling it with water and then emptying out the water. The experiment may now be repeated.

After the idea of fresh air being needed for burning has been well established, it is time to return to the previous pages and discuss the experiments in terms of this new understanding.

Page 51

Fires can be extinguished by covering them with something that shuts out the supply of fresh air. In this picture, soil is being used to extinguish the fire. The teacher should realize that the soil not only shuts out the air but also tends to cool off the fire, a more difficult concept that will be developed in a later grade.

Pages 52–53

This picture story illustrates another application of the principle just studied. The burning clothes of the little girl were extinguished by her father when he wrapped a rug tightly about her.

Discuss with the children the danger of letting their clothes catch on fire and how they can try to avoid it. Stress also what to do and what not to do if their clothes catch on fire. Emphasize the danger of running.

Pages 54–55

The only special suggestion needed for carrying out this interesting experiment with a jack-o'-lantern is that the eyeholes should not be made very large lest a flow of fresh air go in the bottoms of the holes while the hot air goes out at the tops.

To produce the smoke needed to show the air currents, light a tightly twisted roll of facial tissue and then blow it out. The smouldering paper gives a good smoke. Incense sticks may also be used.

Page 56

For this experiment to give satisfactory results, the candle flame should be large compared with the diameter of the chimney. Use a small chimney and either one large plumber's candle or two or three small candles side by side. Try the experiment alone before using it with the children.

In view of previous experiments, the question "Will the candle in the chimney burn?" usually brings an affirmative reply. This is because the top of the chimney is open. Strangely enough, however, the candle goes out. Perhaps there is something wrong. But several trials show that the candle will not burn in a chimney open only at the top.

The last part of the experiment shows that the fire will burn if the bottom of the chimney is open too. Smoke shows that a current of fresh air moves in at the bottom while hot air flows from the top.

If a kerosene lamp or lantern is available it may be studied to see where the fresh air enters and where the hot air leaves.

Pages 57–58–59

These pages apply the principles of chimneys to everyday situations. Perhaps the children can be taken to a fireplace. Some schools and other public buildings have fireplaces which are workable though rarely used. Sometimes a small class may be taken into private home to sit round the fireplace. Burning incense sticks placed before the fireplace shows the path of the air currents.

A trip to the school heating plant may be valuable. The flow of air into and through the furnaces can be described. The draught is often strong enough to draw inward thin strips of facial tissue.

In many communities, nearby homes present a variety of furnace types. Where the cellars can be entered directly from outside without going through the living-quarters of the house, the owners of the homes do not mind a yearly visit by a well-behaved class. The teacher may feel the need for help from a high school science teacher.

Page 60

We cannot make pupils too conscious of the damage and the dangers resulting from forest fires. We must stress the slowness of tree growth and we must show how trees older than any living people can be wiped out in a few hours.

Discuss precautionary measures: how to light matches, when not to light matches, what to do with the burned matches, where to build picnic fires, how to care for them and how to extinguish them, why it is unwise to build fires except under adult supervision.

There may be individuals in the community who can give illustrated talks on the hazards of grass fires and forest fires.

Summary Questions

1. The answer which the pupils will probably give is "fresh air." Of course, the fire also needs fuel and a source of heat to start it burning. These latter needs will be taken up in a later grade.
2. There are several possible answers. The person may be wrapped in a rug or blanket as shown on page 53. The person may be rolled over on the grass or on the ground. The fire may also be drenched with water.
3. The children should describe furnaces they have seen or the furnaces described on pages 58 and 59.
4. The pupils should understand that a wind brings fresh air and blows away air that has already taken part in burning.
5. The children should know that a fire needs fresh air if it is to continue burning. Some children may have heard about oxygen, but it is not likely they have any real understanding of it or its role in burning.

Follow-up

As a follow-up, apply the learnings of this unit to fire prevention at home. Establish some safety precautions. Discuss situations that are dangerous.

Discuss also what to do in case of a fire—how to report a fire, what to do when the firemen come and after they begin to fight the fire.

Fire safety in public buildings is also important—how to look for fire exits and how to leave the building. Encourage the children to look for exits as soon as they enter public buildings.

POSSIBLE LEARNINGS

A fire needs fresh air in order to burn.
We can put out fires by keeping fresh air away from them.
Blowing fresh air on a fire may make it burn faster.
Stoves, furnaces, and other things that have fires in them have places for fresh air to enter and for burned air to leave.

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Brief description of the physical properties of fire.

First Book of Firemen. Mary Elting. Ambassador Books: Toronto, 1951. 44 pages.
A brief text with many illustrations covering many phases of the fireman and his work.

Little Fire Engine. Lois Lenski. Moyer: Toronto, 1946. 48 pages.
An easy book about fire and fire engines.

Films

City Fire Fighters. Coronet.
What the city fire department does when an alarm is sounded.

Fire Exit Drill at Our School. Coronet.
The importance of orderly behaviour during fire drill.

Susan and the Forest Fire. Society for Visual Education.

Flashy the Fire Bug. National Film Board.

Teeth

PURPOSE OF THE UNIT

Schools should do everything possible to improve the health of boys and girls. But it is not enough to tell them what to do; we must help pupils to understand the reasons behind such practices. This means that we must give them the maximum understanding of the human body.

To do this, we have introduced the study of the human body in "We Are Growing," *Exploring Science One*, attempting to make pupils conscious of the growth of their hair, eyes, nails, bodies, and bony framework. In "When We Run and Play," *Exploring Science Two*, we added to their acquaintance with themselves by helping them to study their respiration and circulation. Now we will combine some of these understandings and extend them into a study of teeth. In later books of this Series pupils will study more about bones, muscles, digestion, diet, and about their eyes and other senses.

Pupils at this age are not particularly conscious of their teeth except as they lose some of the first set. This unit acquaints them with the kinds, number, arrangement, growth, and development of their teeth. They learn that the first teeth are replaced but the second set are not replaced. They learn that teeth need care and how to give it. They learn that decay is progressive and can be checked.

This unit also broadens the understanding of teeth by including a little on tooth specialization in various animals.

PREPARING FOR THE UNIT

The essential items for study, teeth, are provided by the children themselves. A few items are useful and help to enrich the unit: small mirrors, for instance, enable the children to look at their own teeth.

A large, dissectible model of a tooth is valuable because it gives a third dimension to the study of the structure of the tooth. Sometimes the skulls of animals can be brought in to show different kinds of teeth. Biology teachers may have animal and human skulls to loan.

X-rays of the skulls of children show the two sets of teeth. Doctors or dentists will sometimes loan these or donate them.

Pupils will often bring in the teeth they have pulled from their own mouths. These teeth will show no roots, the roots having been absorbed before the tooth became loose.

If the teacher will look around, many helpful materials may be found. Biology and health teachers, school nurses and doctors, dentists and physicians, may have at hand such things as charts, models, photographs, specimens, and booklets, which serve to enrich the material given in the text.

List of Materials

Small mirrors
Tooth charts or models

TEACHING THE UNIT

This is a unit that may be motivated by the loss of some pupil's tooth, by the school dental hygienist's regular inspection, or by the finding of an animal's skull. It may be taught at any time of year and whenever some advantageous situation arises.

There are a number of words that the teacher may wish to add to the general vocabulary of the children but which were considered too unusual to be included in the reading material at this level. These are words like *enamel, dentine, nerve, incisor,* and *molar.* Such words may be introduced by using them a number of times in connection with the structure they represent.

Page 61

If desired, this page can be used to introduce the unit. Ask the pupils to look at the picture. **What seems to have happened to the boy? Do all boys lose their teeth? Do all girls lose their teeth? Does anyone in the class lack a front tooth? Does anyone lack a back tooth? Has everyone lost some of his front teeth? Did new ones always grow in? When older people lose their teeth do new ones always grow in?**

Pages 62–63

These pages present a story of the development of a set of the first or "milk" teeth. The time intervals given represent an average; there is considerable variation among different individuals.

Ask the pupils to count the upper teeth and the lower teeth in each picture. On a large blackboard diagram similar to the one on page 65, mark in the teeth as they appear stage by stage.

Encourage the pupils to tell of the development of teeth in their baby brothers and sisters, and to ask their mothers for information about tooth development.

Page 64

Look at the picture of the boy. What is he doing? Has anyone pulled out his own teeth? How did you do it? Did it hurt very much? Was there a new tooth there right away or did it grow in later?

Ask the pupils to bring in some of the teeth they have pulled out.

Study the picture at the bottom of the page. This shows what might be seen if we could look through flesh and bones. Note the two sets of teeth, one set in the mouth and the other set inside the bones. Have pupils feel their jaw bones. Tell them that there are teeth inside the jaw bones and that they will grow out later.

If an X-ray of a child's head is available fasten it to a window pane so that the children can look at it and see the two sets of teeth.

Page 65

Before studying this page try to collect some small mirrors, avoiding those with sharp edges. Prepare duplicated copies of the full set of teeth as shown on this page, using dotted lines to show the location of the teeth.

Ask the children to wash their hands carefully with soap and water because they will be putting their hands into their mouths. Then direct the children to look at their teeth and count them. Ask them to mark the location of these teeth on the duplicated copy by filling in round the dotted outlines. The chart will then show which teeth they have, and the dotted outlines will indicate the ones that have yet to grow in.

The teacher should recognize the fact that many adults never acquire a full set of teeth; the wisdom teeth in particular fail to appear. However, it is not likely that children will raise this problem.

Page 66

Give the pupils mirrors and ask them to wash their hands carefully. Then have them find in their own mouths the four kinds of teeth shown in the picture. This picture shows on each half of the jaw: two incisors, one canine (or cuspid), two premolars (or bicuspids), and one molar. In the adult jaw there would be two more molars on each side.

If it is desired to introduce these terms into the general vocabulary of the pupils at this time, draw labelled pictures on the board, pronounce the words carefully, and use the terms whenever possible through the remainder of the unit.

Page 67

The study of human teeth is here broadened to include the study of the teeth of animals. Skulls of animals, which may sometimes be borrowed from a biology teacher, will help greatly in this study. A cat, dog, or rabbit may be brought into the classroom at different times; the teeth of these animals can be seen as the animals yawn or eat.

Ask the children to pick out the animals that have similar teeth. Explain that teeth are considered to show how animals are related. For instance, all animals with large incisors and no canine teeth are believed to be related.

There is danger that pupils will attempt to generalize about the food habits of animals from a study of their teeth. For instance, the highly developed canine teeth of a black bear would seem to indicate that it is a meat eater that hunts its prey. However, the diet of the black bear is largely made up of insects, berries, and nuts; what meat it eats is rarely captured alive. The fox, too, is largely vegetarian during the seasons when fruits and berries are available; it hunts animals chiefly during the winter months.

Pages 68–69

These pages show two animals with highly specialized teeth. Ask how the long canines of the bobcat may help it while hunting. **Notice the incisors which are too small to be of much use to the bobcat. The molars are useful for cutting rather than grinding. How could this help the bobcat?**

Notice the incisors of the beaver. How does the beaver use them? Notice that a beaver has no canines. See the flat-topped grinding molars. How does the beaver use its molars? The beaver's diet is largely bark that must be ground up fine before being swallowed.

As may be imagined, the incisors of beavers and other gnawing animals wear away rapidly. The teeth compensate for this wear by growing slowly but steadily from the base. If a skull of any of the gnawing animals is available, pull out one of the incisors and show how growth at its base keeps lengthening the tooth. The pupils can also see that the soft portion (dentine) on the rear surface of the tooth wears away faster than the front surface of enamel. Thus the tooth stays sharp.

Page 70

It is believed that there is a relationship between good diet and healthy teeth, but thus far there is no positive proof as to what items of diet are essential. We know that milk contains the minerals essential for tooth growth and we believe that the vitamins in fresh vegetables stimulate the use of such minerals. It seems better to work for a good general diet than to make positive statements regarding the necessity for any particular foods.

Page 71

Few people question the advisability of brushing the teeth properly, but we should not imply that such care will prevent decay. The causes for decay are still poorly understood. In the classroom we can spend our time more profitably by showing the children how to brush their teeth and how to observe simple rules of oral hygiene. Notice, for instance, the rack of toothbrushes of different colours in the picture; children should understand why we do not use each other's toothbrushes, forks, or cups.

Page 72

This page shows the progress of decay. Explain that decay seems to be the result of certain kinds of bacteria which get into the soft parts of a tooth. Perhaps the school nurse or dental hygienist will be willing to talk with the pupils about tooth decay.

Page 73

Strive to give pupils the idea that the dentist wants to help us to keep our teeth healthy and that he can do this better if he finds the cavities when they are small. Ask the school nurse or dental hygienist to explain the work of the dentist.

Page 74

There are thousands of kinds of animals that have no teeth. Insects, for instance, do not have teeth, nor do birds, nor frogs. Grasshoppers have hard jaw-like parts with which they cut up their food. Crayfish have similar mouth parts and they also tear up their food with their claws. Turtles have hard bony jaws that can shear off food. Earthworms swallow earth and digest out whatever food is present in it. Chickens swallow their food without chewing it; the food goes into a muscular gizzard where it is churned around with sharp pebbles that the chicken has swallowed.

The children are usually interested in the manner in which familiar animals are able to eat their foods.

Summary Questions

1. The children may answer that they have two kinds of teeth, the first and the second sets, or the "milk" and the "permanent" teeth. They may also answer that they have four kinds of teeth and describe or name the incisors, canines, premolars, and molars.
2. When the children answer this question try to get them to describe a balanced diet.
3. Normally, the adult has 32 teeth, counting the four wisdom teeth. However, the human jaw seems to be a bit crowded and some teeth never appear in many individuals.
4. The children should recognize that small cavities are easier to take care of, and do less permanent damage than large cavities. They should also realize that decay is progressive and cavities enlarge if they are not treated. Frequent trips, therefore, enable the dentist to stop decay while the cavities are small.

5. The answer to this is, of course, two, not counting such sets of false teeth that some people must have.

Follow-up

As children lose their teeth encourage them to tell about the loss in school. Encourage them to tell about their visits to the dentist and to show what work the dentist did, either cleaning or filling or both. If something unusual arises, such as an opportunity to see a different animal skull, or to hear someone talk about dental care, take advantage of the situation.

POSSIBLE LEARNINGS

People develop two sets of teeth, one as babies, and one as older children.
People have four types of teeth.
We believe a good diet helps children to grow healthy teeth.
Teeth with holes in them may decay and be badly damaged.
Dentists can often stop decay by filling the holes.
Some animals have highly specialized teeth.
Some animals do not have teeth.

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Animal Weapons. George Mason. George J. McLeod: Toronto, 1949. 94 pages.
Animals' teeth are often their best weapons.

Chisel-Tooth Tribe. Wilfred Bronson. W. J. Gage: Toronto, 1939. 200 pages.
The chisel-tooth animals and how they use their teeth.

Films

Ten Little People and their Teeth. National Film Board.

H-38 Teeth Are To Keep. Ontario Department of Education.
A two-dimension animated "cut-out" cartoon designed for primary and junior children. Gives the main points of dental care.

H-39 Save Those Teeth. Ontario Department of Education.
The causes of tooth decay and how to prevent them.

H-24 Your Teeth. Ontario Department of Education.
This film illustrates and explains the structure, growth and care of the teeth.

Animals in Winter

PURPOSE OF THE UNIT

There is no hobby more fascinating than that of studying the activities of animals. In winter, light snows add zest to the sport by providing fresh pages on which animals write their own stories. One can unravel mysteries as complex as a detective novel. The trail of a fox tells of the never-ending drama of the hunter and the hunted.

If we can interest children in this phase of science we will stimulate them to go outdoors by themselves. Perhaps our efforts will some day cause them to develop strong interests in nature photography, hunting, fishing, camping, hiking, or in snowshoeing. In our society people need some outdoor activity to balance the indoor environment and the nervous tension of mental work. What one educator has called "nature therapy" would be invaluable to many people.

With proper guidance, pupils can develop an objective understanding of the problems of living things—non-sentimental but nevertheless sympathetic. If we are to retain our heritage of forests and wilderness areas for coming generations, we must make the public aware of their value and the need for keeping them intact.

This unit fits into a major sequence dealing with animals and animal behaviour. It builds on such units as "Caterpillars" and "Signs of Winter" in *Exploring Science One* and on "Grasshoppers" and "Buds" in Book Two. The four stages of development of the butterfly group are reviewed on page 87, and the place of buds and twigs in the diet of some animals is touched upon again.

In the same fashion, later units build on this one. Units on winter birds and on bird activities in spring are based on experiences given here. The study of bees is given more attention in later units. The "Animal Tracks and Signs" unit in Book Five is a continuation of this unit.

PREPARING FOR THE UNIT

This unit can be strengthened by some advance preparation on the part of the teacher. The teacher should try to find out which mammals and birds are commonplace during the winter season. Some provinces publish books and pamphlets on local species, giving information on the distribution and the habits of common forms. Such publications can be found in public libraries.

Most communities have people who are interested in birds; their assistance is invaluable. Other people are interested in hunting and they can give information about the game mammals. One should not forget to ask the help of those older boys who by hunting, fishing, and trapping have a valuable store of first-hand experience.

Preparation should include looking about the area near the school for possibilities for field observations, both by the class as a whole and by individual pupils. Even in the midst of cities, parks and vacant lots provide numerous opportunities.

TEACHING THE UNIT

A light snowfall makes an excellent beginning for this unit. The tracks of dogs and other animals stimulate the study of animal tracks.

In regions where there is no snow, the first section of this unit can be treated as a picture story. The information gained can be applied to the animals living in the region. Where the climate is always mild and typical winter conditions do not exist, it may be advisable to treat this unit briefly and use the remaining time for units that apply more closely to local conditions.

Page 75

Here two common tracks are compared. Note that each animal has the same number of toes and that each walks on the tips of his toes with the "heel" several inches off the ground. Note, too, that the cat does not show prints of its claws, and that unlike dogs in general, the cat puts its hind feet in the prints made by its front feet.

A cat and a dog brought into the class at different times will show some of these characteristics to the class. The claws of the dog click against the floor; the cat walks on "velvet paws." If the animals are docile, one may press their feet on a stamp pad and then on paper to get footprints. One may also press their feet into modelling clay to make the prints.

Both cats and dogs are so common that short trips around the school are certain to show the patterns of their tracks on any snowy day. Even without snow, the tracks can often be found in muddy places; and even on dry sidewalks tracks can be found after the animal has walked through a puddle.

The patterns of animal tracks can be recorded in notebooks or in the class scrapbook. They can also be made into a decorative frieze for the blackboard.

Pages 76–77

Almost every locality has rabbits, even densely-settled residential areas. Rabbit tracks are easy to distinguish; the hind feet are set down side by side, and in normal gait they always fall ahead of the front feet. One front foot usually falls a little ahead of the other, thus making a diagonal pattern for the front-foot tracks.

Rabbit trails are not easy to unravel because the rabbits move about so much, but many of their activities can be read from the snow. Contrary to popular fiction, our native rabbits do not dig tunnels, although in severe weather they may retire into tunnels of other animals.

If a tame rabbit can be brought into the classroom, the pupils can see why a rabbit makes the track pattern shown in the text.

Pages 78–79

A city park is a good place to find squirrel tracks. In rural regions, one must find a place where a squirrel has its territory before taking the class to look for squirrel tracks.

The activities of squirrels in winter are not complicated; their track stories are relatively simple to unravel and are usually found to be associated with feeding. There will, of course, be gaps in the record if the squirrels take to the trees.

The various squirrel tracks are much like rabbit tracks. Tree-living squirrels usually put their front feet down side by side rather than diagonally, although there are variations from the typical pattern.

Pages 80–81

Deer are becoming more numerous in many regions during late years and they are spreading their range into regions where before they were rarely seen. Although deer are often shy and may not be seen by the children, the tracks are easy to distinguish. Pupils are greatly excited by the knowledge that a deer has passed by, even when they see only the tracks.

Deer tracks resemble cow tracks slightly, but deer tracks are much smaller and much sharper at the front. When walking, the deer usually puts its hind feet in its front-foot tracks. While bounding, the feet come down in the pattern shown on page 81.

The deer shown here is referred to as "he" but has no antlers. Male deer lose their antlers in early winter. In late winter or early spring a new set begins to grow and is complete by midsummer.

Pages 82–83

A crow track can be distinguished because the inner toe is held closer to the middle toe than is the outer toe. Crows are often found around garbage dumps and cornfields in winter.

Pheasants may not show a mark of the hind toe in shallow snow. Like crows, pheasants walk, they do not hop. The tail may or may not drag in the snow.

Gulls often visit garbage dumps and grain fields. Their tracks show the webs between the toes.

Sparrows hop rather than walk. Their track may be seen in weed-grown lots and around feeding stations. Crumbs and grain thrown on the snow may attract some of them for observation.

Pages 84–85

Several mammals react to very cold weather by crawling into dens and going to sleep. This is not true hibernation because the body temperatures stay high and the mammals become active during periods of warm weather. The extent of the "sleep" varies over the country with the severity of the climate. A teacher must acquaint herself with the habits of local species before acting as an authority.

A relatively few species undergo true hibernation, during which the body temperature drops and life processes almost cease. The beginnings and endings of hibernation are sharply marked, and awakening in midwinter is rare. There is still much speculation and uncertainty as to the causes and effects of hibernation.

Pages 86–87

The activity of the so-called "cold-blooded" animals varies with the temperature of their environment. These animals are not truly cold-blooded; their temperatures approach those of their surroundings so that on a warm day one of these animals may be as warm as a person. But in winter, their temperatures drop and the animals become inactive. Usually they react to the approach of winter by seeking a protected spot in which they go into the inactive state. The frog and the turtle shown on page 86 are not *on* the barren bank of the pond: they have burrowed into the sub-surface soil, but have left no path of their burrowing.

Insects are "cold-blooded" and some become inactive in cold places. Many of them die and only their eggs survive through the winter. This behaviour pattern has already been touched upon in the "Grasshoppers" unit in Book Two. Other insects may pass the winter in any one of the other stages. Page 87 shows that different species of the moth-butterfly group pass the winter in different stages. Tent caterpillar eggs, like those at the left of the page, may be found on the twigs or trees and bushes. Cocoons and chrysalids of many other species may be found suspended from twigs, beneath rough bark and beneath boards; some chrysalids may be found in soil. A cocoon of the Cecropia moth is shown at the top of the page. The woolly bear caterpillar, shown at the bottom, spends the winter under boards or stones and will occasionally be found moving about in the open on warm days. Butterflies and moths of some species spend the winter in the adult stage and may be seen on warm days; the species pictured on this page is the mourning cloak butterfly.

If possible take trips to find insects wintering in the different stages. It is well to look over the territory first.

Page 88

This page refers to one type of food storage. In a few localities a trip to a beaver dam is possible, but usually the children can only read about beavers.

Muskrats build smaller, but similarly shaped homes of grasses, reeds, sticks, and mud as winter approaches. These houses are more commonly seen than beaver houses, and pupils in rural areas can usually find them. Children enjoy studying the habits of these animals. It should be noted here that muskrats do not store food but search all winter for roots of aquatic plants, fresh-water clams, frozen apples, winter wheat, and similar foods.

Children also enjoy reading about the food storage habits of such other animals as squirrels and chipmunks.

Page 89

The food storage habits of honeybees are always interesting. The teacher may bring in a honeycomb for study, uncapping some of the cells to show the honey inside. She should also let the children taste the honey. An extensive study of bees is not recommended in this midwinter unit; there is opportunity for such study in the fifth-grade unit, "Insects That Work Together." If any child asks what the bee hives have been covered with, they may be told that the hives have been covered for protection in winter.

Pages 90–91

The track stories on these pages can be treated somewhat like puzzles for the pupils to solve. After the pupils have looked at the pictures ask several pupils to give their versions of each story. Permit them to discuss the different versions and decide upon one or more that seem likely. Do not try to influence their thinking too much.

The following information may help in guiding discussions:

1) A hopping animal went up to some blackberry bushes, sat for a while and then hopped away. The position of the forefeet in the tracks (one track slightly ahead of the other) indicates that this was a ground-living mammal, probably a rabbit. One blackberry stem has been cut off; the rabbit probably ate it while it sat there.
2) A bird walked up to a corn stalk, walked away a few steps and took flight. The walking gait and the pattern of the toes in each print suggest that the bird was a crow. It was probably attracted by the corn, which crows feed on in winter. It might have been frightened away.
3) A hooved animal walked up to some saplings and then walked away. The shape of the footprints and the tendency of the animal to put its hind feet in its front footprints suggest that the animal was a deer. It probably ate some of the twigs from the saplings.
4) A bird with a long tail walked up to a burdock plant and then walked away. The shape of the tracks and the dragging tail suggest that the bird was a pheasant. The bird probably ate some of the burdocks—common winter diet for pheasants.
5) A small bird landed at the base of a weed stalk, hopped about in the snow under the stalk, and then flew away. It was probably some type of sparrow looking for seeds that dropped from the weed stalk. Sparrows hop in this way and also feed on weed seeds in winter.
6) An animal hopped across the snow, stopped to dig a hole, and then hopped to a tree where the tracks end. The position of the forefeet (side by side) in the tracks indicate that the animal was a tree-living animal, probably a squirrel. The squirrel dug up a nut or acorn which it ate on the spot, as indicated by the bits of shell scattered nearby. It then went to a tree and climbed it.

After reading the stories the pupils may wish to write similar stories of their own. They may copy their stories on the blackboard or on a long sheet of wrapping paper to be used as a frieze along the wall. Their stories will be especially interesting if they are based on tracks actually seen in the field.

Page 92

It will be noticed in this Exploring Science Series that there is no planned study of bird migration in the first two grades. Small children barely notice the presence of birds in general, to say nothing of noting the absence of certain species.

But after the study of birds in the second grade, it is probable that the children have recognized enough species to note the absence of some of them at this time. The three birds shown here are species that leave Canada in winter. Each locality also has other birds which leave the region during the winter months.

Summary Questions

1. The children may tell about the absence of claw marks in the cat track. They may also describe the difference in shapes, the cat track being somewhat rounder than the dog tracks. Or they may tell how the cat usually puts its hind feet in its front-foot tracks, a habit that few dogs have.
2. The children may describe how, in general, the front feet of the rabbit come down diagonally, whereas the front feet of the squirrel come down side by side. The latter habit applies only to the tree-living squirrels.
3. The experiences of the pupils may enable them to list a large number of winter foods of rabbits. The chief diet in snow-covered regions is bark and twigs.
4. The answer to this question depends upon the locality. House sparrows, sometimes called English sparrows, are winter residents around dwellings in most parts of the country.
5. Woodchucks hibernate in their burrows throughout much of the winter.
6. Insects usually become quiet when the weather is cold. Many die, and only their eggs survive. Other insects live through the winter in various stages, depending upon the species.
7. The experiences of the pupils may enable them to list many different foods for winter birds. Insect eggs and inactive insects are eaten by some birds. Seeds are eaten by many others.

Follow-up

There are a number of children's books on animal habits. Independent investigations in these books help add to the general background of information about animals in winter.

As days of good tracking occur, more study of tracks may be added to the work of the unit. Children may study tracks by themselves. Encourage them to make picture records and to write stories about their observations.

As spring comes, the increased activity of animals can be related directly to the work of this unit.

POSSIBLE LEARNINGS

Winter weather presents many problems to animals.
Some animals feed on different foods in winter.
Some animals become inactive in winter.
Some animals go to other regions in winter.

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Books

Animals Round the Year. Glenn Blough. Copp Clark: Toronto, 1943. 34 pages.

Tells how animals prepare for the changing seasons.

Audubon Nature Bulletins. National Audubon Society, New York. 4 pages each.

Several of the bulletins contain background information to supplement this unit. List sent by the Society on request.

Audubon Teacher's Guide. National Audubon Society: New York, 1948. 90 pages.

This is a teacher's guide to activities and source material.

Cornell Rural School Leaflets. Cornell University. Thomas Allen: Toronto.

The leaflets contain background material and information on almost every science topic. Consult the list of titles.

Handbook of Nature Study. Anna Botsford Comstock. Thomas Allen: Toronto, 1947 ed. 937 pages.

Valuable for general reference and as a teaching guide. An up-to-date natural history library in one volume.

Out of Doors in Winter. Clarence Hylander. Brett-Macmillan: Toronto, 1943. 146 pages.

Teacher and more advanced pupils will find help on winter birds and winter mammals and their tracks.

Film

Animals in Winter. Encyclopaedia Britannica Films. Ontario Department of Education: SN-99.

Common animals are shown as they prepare for and live in winter.

Water in the Air

PURPOSE OF THE UNIT

This unit presents experiences which lead to an appreciation of the importance of water in the air and which develop understandings regarding the common changes that water undergoes in the world around us. The unit is one of a series centred around the study of the atmosphere. It builds upon the first-grade unit "Rain" and "Air," and upon the second-grade units "The Thermometer" and "Watching the Sky." In its turn, this unit provides a background for such later units in this Series as "Growing Plants Indoors" and "Warm Air in Motion." The unit also helps in understanding many other experiences which deal with humidity and plants.

Like so many other units in this Series, the emphasis is placed upon learning by doing. Pupils are shown how to carry out a simple experiment and then they are shown applications of the concepts developed in the experiment.

There is always a tendency to hurry simple experiments, feeling that once the children have seen an experiment performed they should move on to something else. However, something covered is not necessarily something learned. For the success of the science programme the pupils should have an opportunity to participate individually and to repeat the experiments as much as they wish. It must be remembered that pupils learn best through the use of several senses, not just vision alone. They should have opportunities to check their observations and to develop the habit of questioning the results of a single observation.

PREPARING FOR THE UNIT

The unit may be taught at any time of the year; it is located in the middle of this book so that there may be ample opportunity for follow-up.

No special preparations are needed save for collecting the materials needed for the experiments. These materials include drinking glasses, bottles, pieces of cloth, tin cans, and a gallon glass jug. A potted plant such as a coleus plant and a pot containing soil are needed for the experiment on page 102. An electric hot-plate or other source of heat is desirable to show the effects of heat on evaporation.

List of Materials

Drinking glasses
Medicine dropper
Metal pan
Ice
2 Cellophane bags
Potted plant such as a coleus plant
Pot of soil
Cloth
Yardsticks
String
Tacks
Shoebox
Hot-plate or other source of heat
Milk bottle
Teakettle or glass coffee pot
Tin cans
Gallon glass jug

TEACHING THE UNIT

The pupils will be dealing with two invisible, almost intangible, substances—air and water vapour. We cannot expect complete understanding and we must not be impatient with the pupils. It is to be hoped, of course, that the planned experiences with air during the two preceding years will have given the pupils some concept of air, but we cannot be sure that they have a true appreciation of it as a gas which surrounds us.

At this time we can only begin to develop an appreciation of water vapour as another gas somewhat like air. But by building slowly and carefully we can help the pupils to gain a background needed for the concept. Neither hurry the pupils nor ask for verbalizations too soon. Concentrate instead upon giving experiences.

A few words that may give trouble are used in this unit. The word "evaporate" is not usually a part of the vocabulary of children, but it is a useful one because it applies to a process that cannot be described easily in simpler words. The word "condense" is even less common but is also a useful one. The term "water vapour" is used to name the gas formed as water evaporates; this gas is invisible and mixes with air. The word "steam" is not used because it has two different and conflicting meanings. In common usage it applies to the visible cloud of tiny drops of water seen over warm water. Technically it means water vapour, the gaseous form of water. When children use the word they will probably have the former meaning in mind, but occasionally some child may have read a book that employs the more technical meaning and he will use the term in the second sense.

Although the words "dew" and "frost" will probably be familiar to the children, they have been introduced in this unit with explanations well within the grasp of most pupils at this level.

Page 93

The title page with its picture of a rainy day can be used to set the stage for a discussion that leads into the unit. **How do we know that it is a rainy day? Where does the rain come from? Why does it fall? How did the water get into the clouds?**

Lead the discussion in the importance of rain to us, to plants, to streams. Encourage the children to think of the many uses we make of the water that falls on the land around us. Touch a bit upon the occasional damage too much rain causes.

Page 94

This common experience is repeated in order to introduce the term "evaporate" in association with something familiar to the pupils. Ask them to recall similar situations in which water disappears in the same way—rain on a road, water sprinkled on a sidewalk. Use the word "evaporate" in each case.

Page 95

This experience adds something of the quantitative aspect to the study of evaporation. The balance may be any thin stick, such as a yardstick. It may be suspended by a string from a door frame as shown, or from any other convenient support. A carpet tack will hold it.

Fasten the wet cloth on one end and tie a small bottle on the other end. An easy way to make the two balance is to add water to the bottle or take a little away with a medicine dropper. Then let the balance stand. As water evaporates from the cloth, that end will rise.

The experiment permits some roughly quantitative measurements. After the cloth dries, water may be taken from the bottle until the cloth and the bottle are in balance again. The amount of water taken from the bottle is the same as the amount that evaporated into the air.

Pages 96–97

This is an experiment that can be carried out by small groups of the pupils. Care should be taken that the water level is the same in each of the two glasses at the start. One glass may be covered with a piece of glass or a piece of cardboard. This gives a control for comparison with the water in the other glass the following day.

Page 98

In this controlled experiment we are dealing with condensation of water vapour. The term "dew" is usually applied to the condensed water vapour that forms on grass and spider webs, but is equally applicable here and is better than the term "steam" which is sometimes used.

If the air in the room is very dry, dew may not form at the temperature of melting ice. Some salt added to the ice usually lowers the temperature enough to produce dew.

The children may have had other experiences with the condensation of water on cold objects, such as dew on cold-water pipes in summer, on glasses of cold drinks, on metal objects brought into a warm room from outdoors in winter, and on car windows.

The purpose of the control in this experiment is to show that the moisture did not go through the metal of the can.

Page 99

Our breath contains a good deal of water vapour. Dew is formed on the window pane because the pane is colder than our breath. When the box is removed from the window pane the tiny drops of water usually evaporate again.

The children may have noticed the formation of dew on windows at home, particularly in cold weather when there is much moisture indoors as when something is boiling on the stove.

Page 100

This is another controlled experiment. The factor that differs in the two pairs of glasses is the temperature of the water. Hot water from a hot-water faucet is usually warm enough to produce a clouding of the upper glass.

Page 101

Try to give the children the chance to see the boiling of water and the formation of steam. Even better for the purpose than the teakettle shown is a glass coffee pot or a glass chemical flask with a stopper and glass tube used in the mouth of it. Then the teacher may point out to the pupils that the water vapour inside the vessel cannot be seen.

The children will probably ask about the little cloud that forms near the mouth of the vessel. They may call it "steam." This little cloud is made up of tiny drops of water that have condensed from the water vapour coming from the vessel. As the cloud moves out into the dry air of the room, the drops of water evaporate.

Page 102

This controlled experiment should help the pupils to understand the source of some of the water vapour in the air and also what happens to the water that goes into plants.

A plant that evaporates water rapidly is best suited to this experiment. A garden plant, or a wild plant, may be dug up and used for this experiment. If house plants must be used, use one with a large leaf surface such as coleus. Some house plants such as geraniums are not satisfactory because they are adapted for dry air and do not lose their water rapidly.

The purpose of the cellophane bag that is tied to the stick is to show that moisture does not condense from the air on the bag in quantities great enough to show, but that the moisture is given off by the leaves.

Page 103

This is a discussion page that permits the pupils to apply their learnings from the experiments that they have been doing. Evaporation is taking place from the trees and other plants, from the lake, from the wet clothes on the line and on the boy, and from the kettle. Condensation is taking place over the kettle and high in the air as clouds.

Ask the pupils to look from the windows and tell where evaporation is taking place and where condensation is taking place. Ask them to mention other places where there might be evaporation and condensation.

Pages 104–105

These are discussion pages to recall pupil experiences with dew and frost. Is there dew on the grass every morning? Does the dew form on other things besides plants? What happens to the dew in the morning? When do you see frost on windows? When do you see frost on plants? (A purple aster and some branches and leaves of wild apple are shown.)

Some sections of the country never see frost patterns on windows and some never see frost on plants and roofs. These facts may be pointed out to the children. The mechanics of why frost forms in such patterns is not completely understood. We do know, however, that they are not the result of frozen dew; rather, they represent the change of particles of water vapour directly into particles of ice.

To produce some frost in the classroom, pack alternate layers of crushed ice (or snow) and salt in a small aluminum kettle. Unless the room is very dry, moisture will form on the outside of the kettle. This process is similar to the formation of frost inside a mechanical refrigerator.

Pages 106–107

These information pages deal with the cloud cover. They show that clouds form in a layer above the earth and that above the clouds there is a clear sky where airplanes can fly. Perhaps some of the pupils have flown above the clouds and may relate their experiences.

Page 108

This demonstration delights children. Give each one an opportunity to try it for himself. The purpose of the lighted match is to put into the air of the bottle some dust particles on which the moisture can condense. The piece of ice cools the warm, moist air enough to condense some of the water vapour. The water vapour condenses on the smoke particles and forms a cloud.

Page 109

This page applies the information gained on the previous page. It tells about clouds and fog and how they form at different levels.

Sometimes the drops of water in a cloud become big and heavy enough to fall as rain. This process is not well understood.

Clouds may also be formed of ice crystals that form on dust particles when temperatures are below freezing. If these crystals are large enough they fall as snow.

The concept of "cloud" has already been introduced in this unit, making the concept of "fog" one with which the children should have no difficulty.

Pages 110–111

These pages give information about the effect of clouds on airplane travel. The teacher may explain something of federal regulations concerning airplane travel. Perhaps a person who has some training in this field can be asked to talk to the children, but care must be taken that he recognizes the limitations of his audience.

Page 112

Rain is the most common from of precipitation, but snow is not uncommon. Snow forms when the air in which condensation is taking place is below the freezing temperature. However, snow may fall when the air at the earth's surface is *above* freezing, having formed in a freezing temperature at a higher level. The air at higher levels is usually colder than ground temperatures.

Summary Questions

1. The children should be able to list many places—standing water, boiling water, drying cloth, plants, our bodies, anything that has moisture on it.

2. They have had enough experiences to name a number of things that are cooler than the air about them—cold glass of lemonade, cold window glass, plants on clear nights.

3. This question is more difficult for children to answer. Dew and frost are formed when objects outdoors become cool enough to condense water vapour in the air. This usually happens on clear nights. If the temperature is below freezing, frost forms.

4. Clouds are tiny drops of water that have condensed on particles of smoke and dust when the water vapour in the air is cooled enough.

5. Fog is a low-lying cloud.

6. Water can be made to evaporate faster by heating it. Perhaps some of the pupils will remember the experiment from the second-grade unit "Wind" and will suggest that a wind also helps to evaporate water faster.

7. Airplane pilots are interested in clouds because clouds make it difficult to see. Low clouds keep the pilot from seeing the ground. Higher clouds keep him from seeing what is about him. Pilots are also interested in clouds because the clouds tell them something of

the weather, particularly the nature of the winds in the cloudy area. Pupils may or may not know about this aspect of cloud study.

Follow-up

There are almost unlimited opportunities to help the pupils to discover and discuss applications of the principles studied in this unit. There will be numerous situations in which evaporation is involved. There will also be some in which condensation is involved.

Pupils will see several forms of precipitation and different kinds of clouds. These should all be discussed as they are seen.

POSSIBLE LEARNINGS

Water can change into water vapour.
Heat speeds up the evaporation of water.
If water vapour is cooled enough it condenses.
Clouds and fog occur when water vapour condenses on particles of dust in the air.
Dew and frost are formed when cold objects condense the water vapour in the air near them.

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Making Things Move

PURPOSE OF THE UNIT

This unit introduces the concept of energy and presents experiences which clarify the meaning of the term. The civilization we live in is characterized by the use of tremendous amounts of energy. We use the energy of coal and gasoline for transportation and travel. We use the energy of fuels to heat our homes and to cook our foods. We use electrical energy for radio, television, lighting, manufacturing processes, labour-saving devices, and for hundreds of other purposes. If children are to be able to interpret the multitude of activity in our world they must know about energy.

Experiences with electricity, fire, wind, magnets, heat, and other things which involve energy have already been offered in several earlier units, but the word "energy" has not been introduced up to this point. Now a clear understanding of what is meant by energy and the ability to use the term correctly is needed in succeeding units relating to such things as airplanes, heat, boats, machines, electrical circuits, electromagnets, plants, and weather.

An appreciation of what is meant by energy is best built up through experiences with common things. It is important that pupils have these experiences. Mere verbalization about energy can never result in a true understanding of the concept or make the word useful in thinking.

It will be noticed that this unit calls for many activities on the part of the pupils, including things for them to make. They will be gaining more than concepts and the ability to use the word "energy": they will be learning co-ordination of muscular effort and they will be gaining information about materials and tools through their muscular senses.

PREPARING FOR THE UNIT

The concept of energy is introduced through the use of wind-up toys. Several of these should be on hand for the first lesson. Children in the class may bring them in, and possibly older children will donate some. Other spring-wound devices such as clocks and mouse traps may be brought in to demonstrate the storage of energy in elastic substances.

A few common materials are needed for making the two wind-up toys described on pages 120–125. These include spools, wire coat hangers, rubber bands, long carpet tacks, scraps of lumber and large nails. The tools needed include a hammer, wire-cutting pliers, and a saw.

List of Materials

Spring-operated toys and similar devices
Scrap lumber (small pieces)
Long carpet tacks
Hammer
Empty spools
Wire coat hangers
Pliers
Rubber bands
Large nails
Saw

TEACHING THE UNIT

It is not profitable to attempt to define the term energy for young children. It is better for them to learn it through context; they should hear and see the term used correctly in various ways until they have gained the ability to use it themselves. At the beginning of this unit, the word energy is applied only to the energy stored in elastic substances; at the end of the unit the term is broadened slightly. In later units it will be applied to a wide range of situations.

Page 113

On this page are pictured a few moving things. **What makes the bicycles move? What other things do we move with our feet?** The children will probably suggest tricycles, scooters, and toy automobiles. **What makes the baby carriage move? What are some other things we push?** The children may name toy wagons, carts in grocery stores, lawn-mowers, wheelbarrows, and similar devices.

Ask them to discuss the swings and how children make the swings move. **How is the ball made to move?** Ask the children for suggestions of other things that we move with our arms.

What makes the automobile and the truck move? What other things have engines or motors in them that make them move? The children will probably suggest such things as airplanes, motorcycles, and power lawn-mowers.

Pages 114–115

Ask the children to read these pages and discuss the toys shown. Then wind up a toy and watch it run. Use the term "energy" when referring to the behaviour of the toy.

Demonstrate other toys and use the word "energy" in connection with them. Plan an exhibit of spring-wound toys; let the children prepare labels for the toys, explaining what the stored energy does in each case.

Pages 116–117–118

Children will see that winding an alarm clock is somewhat like winding a mechanical toy. The energy put into winding the clock mechanism is used to move the minute and hour hands slowly. The energy given to the alarm mechanism is stored until a pre-set time when it rings a bell.

Bring in a spring-operated alarm clock. Let the children wind it every day and let them set the alarm for a certain time, such as the beginning of a play period.

Discuss the mouse trap and the screen door spring. Continue to use the term "energy" as applied to these devices. Bring in a mouse trap and show how it is set and how the energy is used.

Refer to, and demonstrate when possible, other spring-operated devices such as spring-wound phonographs which many children have, window-shade rollers, pop-up toasters, and push-button electric switches. Take apart discarded devices that contain springs to show where the energy is stored.

Page 119

Some children may not be participating in the discussions or getting enough first-hand experiences. Here is an activity that every pupil can carry out for himself, and by so doing add to his concept of what is meant by energy.

Supply each pupil with a rubber band and a string about two feet long. Direct them to carry out the activity described on this page. The use of the kinesthetic sense will broaden the concept of energy beyond that gained by seeing someone else demonstrate. They will realize that they give the rubber band energy when they stretch it, and that the stored energy makes the book move when the rubber band is released.

Pages 120–121

Building a toy boat of this type makes a good home project as well as a good classroom activity. One or more boats should be constructed in class so that any special problems that arise may be solved. The piece of board may be sawed in the classroom or in the school shop. A board about a foot long makes a convenient size. The paddle wheel can be made of any thin wood such as the kind from which berry baskets are made.

The boat may be tested in a large aquarium or a water-tight sand table. At home it may be tested in the bath tub. Discuss the way that energy is stored in the boat.

Pages 122–123–124–125

These pages describe another toy which the pupils can make easily. The materials are common and the procedures are simple. If desired, instead of driving a tack into the spool as shown on page 122, a small hole may be bored in the same place. Then the rubber band can be anchored by pushing a wooden toothpick into this hole far enough for it to reach the centre hole of the spool.

Do not minimize the importance of the manual skills being developed by these construction activities. Many understandings are impossible to develop through verbalization or even through demonstration. There are no adequate substitutes for actual, first-hand experience where mechanics are concerned.

Pages 126–127

The concept of energy is now broadened a bit to apply to other conditions that cause motion. The simple water wheel illustrated is easy to make, and most children will want to make one. Many children will make such water wheels at home. Any stiff cardboard will serve, but waterproof kinds will last longer. Pieces of metal cut from a tin can cover last best of all.

Page 128

The concept of energy is further extended to include the form stored in gasoline. This broadened concept will be developed more fully in later units, but the teacher may, if the children seem ready, discuss with them the source of the energy that makes such things as coal-burning locomotives move.

The teacher should stress the fact that gasoline, in making an automobile run, does not flow like water did (pages 126–127) against the vanes of a water wheel: rather the gas explodes in the (cylinders of) engine.

Summary Questions

1. The most important generalization of this lesson is the answer here—that energy can make things move.
2. The children may name any of the toys pictured on pages 114, 115 and 118, and they may also add others with which they are acquainted.
3. The energy in falling water makes a water wheel turn.
4. The experiences of the children should permit two answers: by stretching the rubber band and by twisting it.
5. Energy runs our clocks, operates mouse traps, closes doors, turns water wheels and runs automobiles, together with any other services with which the children are familiar.
6. The children should know that a spring can store energy because after it has been twisted, stretched, or pressed, it can make something move when it is released.

Follow-up

Children will often acquire new toys that illustrate the principles of energy storage and use that have been developed in this unit. They will also encounter other devices that store energy in springs. Encourage the children to bring as many of these things to school as they can, and encourage them to describe the others.

On field trips, the class will frequently see machinery that makes use of some form of energy with which they are familiar. A power shovel may use the energy stored in gasoline, and a railroad train uses the energy stored in coal or oil. Take advantage of as many of these situations as possible.

POSSIBLE LEARNINGS

Energy can make things move.

Energy can be stored in springs and rubber.

Falling water has energy.

Gasoline has energy stored in it.

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Books

Experiments with Science. Nelson F. Beeler and Franklyn M. Branley. Ambassador Books: Toronto, 1947. 116 pages.

A collection of experiments which can be carried out with simple equipment.

Fun with Science. Mae Freeman and Ira Freeman. Random House: Toronto, 1943. 60 pages.

A good source of additional activities.

How Things Work. Creighton Peet. Clarke, Irwin: Toronto, 1941. 115 pages.

Interesting information about elementary mechanics.

I'll Show You How It Happens. Marie Neurath. Chanticleer Press: New York, 1949. 32 pages.

Answers many natural questions in simple text with illustrations.

Now Try This. Herman and Nina Schneider. S. J. Reginald Saunders: Toronto, 1947. 40 pages.

Simple mechanics well illustrated.

Films

Energy. Gateway.

A meeting of the model airplane club introduces various types of energy.

Friction. Young America Films.

Explains what friction is and how we use it.

Machines. Gateway.

Simple machines for very young children.

Magnetic Poles

PURPOSE OF THE UNIT

In *Exploring Science One,* children were given an acquaintance with magnets and learned some of the things that magnets can do; in Book Two they learned—in the unit "Rust"—that the metal iron is attracted to a magnet. Now we extend their experiences with magnets to include something on the nature and behaviour of magnetic poles.

After a number of experiences which develop the concepts of magnetic repulsion and attraction, the principle of the compass is studied. The cardinal points of the compass are illustrated. Thus the topic of direction, introduced in "Watching the Sky," Book Two, is rounded out at a time when pupils are becoming conscious of distant places and travel.

The sixth-grade study of electromagnets—telegraphs, telephones and motors—is based upon the work of this unit. Phases of the study of bird migration, map-reading, and position-finding are likewise based upon this unit.

Besides the subject-matter values of the study of magnetic poles, we find many manipulative possibilities in this unit. Through the act of bringing one magnet near, but not too near, another magnet, pupils develop muscular co-ordination and the tactile senses. We should never forget that these developments may be as important as the development of subject-matter concepts.

PREPARING FOR THE UNIT

There must be sufficient materials to take full advantage of the opportunities for individual manipulation. Ideally there should be one bar magnet for each pupil, so that by working in pairs, the pupils can test the behaviour of one magnetic pole toward another. If it is not possible to have so many magnets, the children may work in larger groups; but always the increase in size of a group results in a decrease in the amount of individual participation. In larger groups, too, more aggressive children take over the activities, and retiring children, who need the most opportunity to develop, are pushed into the background.

Part of the weakness of having insufficient materials can be met by placing some of the magnets on a small table in one corner of the room. There individual children can work with the magnets when they have free time.

A few other materials are needed. At least one horseshoe magnet is called for, and at least one magnetic compass. Iron filings are needed; these usually come in containers like salt shakers. A substitute for iron filings can be made by crumbling up steel wool.

List of Materials

Bar magnets
Horseshoe magnet
Iron filings
Tacks
Thread
Darning needles
Corks
Compass
Glass or crockery saucer
Lodestone
String
Knife
Shears
Milk bottle

TEACHING THE UNIT

The activities suggested in the text are simple and easily carried out. Each activity leads into the next, and the whole unit is compact. It may be studied at any time when other units do not take precedence because of seasonal demands.

The only new science terms introduced are "magnetic" and "compass." The latter word is probably already known to the pupils as having two meanings: they have seen magnetic compasses and many of them have used drawing compasses. These two meanings of "compass" should be discussed with the pupils. The context of the term "magnetic" on page 130 should help the children to grasp the meaning of this term. (The word "pole" was first introduced in this Series in Book One.) Further extension of the term "magnetic pole" may be made with the experiment on page 138, which refers to the magnetic poles on the earth's surface.

Terminology used in naming the magnetic poles is confusing. Originally, long before magnets were understood, the pole of a compass that pointed north was named the north pole, and the pole that pointed south was named the south pole. Later, when it was learned that unlike poles attract, it was realized that the earth's magnetic north pole must be unlike the north-pointing pole of the compass. Then arose the problem, should the earth's magnetic pole in northern Canada be called the "south magnetic pole" or should the name of the pole on the compass be changed? Some authorities use one terminology and some use the other.

We have tried to evade the issue at this early level by labelling one pole of a magnet the "N" pole and the other the "S" pole. These letters can stand for "north" and "south" or for "north-seeking" and "south-seeking." When the children are older and understand the theory of magnets better, they will be less confused by awkward terminology.

Page 129

Use this page to review understanding of magnets—what magnets will pick up, what they will not pick up, what magnets will do, and what shapes of magnets children have seen.

If the children have missed the work of *Exploring Science One* on magnets it may be well to give them some of the basic experiences described in Unit Six of this first book.

Pages 130–131

These pages give two experiences showing that magnetic forces are strongest in certain portions of a magnet. Few verbal directions are necessary, the pictures and the text give enough information.

Do not hurry the children through these activities. Let them try the experiments several times. Children like to repeat the second experiment, moving the magnet about under the card and changing the position of the filings.

Review the learnings of the lesson. **Where do the iron filings collect the thickest? Do any collect at the middle? Did any magnet have just one pole? Did any have more than two poles? How many poles shall we conclude there are in bar magnets? Where are these poles?**

Caution the pupils against believing they have proven that all magnets have two poles: they have proven only that their bar magnets have two poles. Actually, it is possible to produce three and even more poles in a bar magnet although this is not often done.

Pages 132–133

Nearly all bar magnets have at least one end marked to indicate the pole. If only one pole is marked put the proper letter on the other pole with a crayon.

Following the directions on these pages the pupils should be able to discover for themselves the principles of magnetic attraction and repulsion. Let the pupils carry out the activities unhurriedly. Then summarize the observations on the blackboard. The summary may look like the following:

Two N poles push each other.
Two S poles push each other.
An N pole pulls an S pole.
An S pole pulls an N pole.

The work of these pages can be enriched by a number of additional experiences. Round bar magnets laid side by side with like poles together will roll apart when released. If one of the bars is pushed toward the other, the second one will roll away.

There is an amusing toy consisting of two little dogs mounted on small but strong magnets. See if the children can explain the behaviour of these little dogs.

There is a device in which a small metal bar seems to hang unsupported in mid-air. Actually the bar is a magnet and there is another bar magnet hidden in the wood of the base. High school science teachers often have this device and are willing to loan it for demonstration to children at the elementary level.

Pages 134–135

Following the directions given here the pupils can magnetize needles, pen points, screwdrivers, and other steel objects. In each case ask them to find how many poles they have given the magnet. They may find out by dipping the new magnet in iron filings.

Following the experiment on page 134, the children will find that the end of the needle which has been stroked by the S pole of a bar magnet will become an N pole.

Pages 136–137

There are many possible activities using magnetized needles. Two of these are described here. In the first one suspend the thread from a ruler projecting over the edge of a desk as shown on page 133.

In the second exercise it is necessary to have a dish made of something other than iron. Crockery soup dishes will serve.

For enrichment show the children the behaviour of a magnetized needle on a pane of glass when a strong bar magnet is moved about underneath. Also suspend two magnetized needles by threads through their eyes. If the points of the needles are magnetized alike, the two needles will stand stiffly apart. Then see what happens when a bar magnet is brought nearby.

Magnetize four needles the same way, that is, with the points having the same poles. Thrust each of the needles vertically through a disk of cork and float them in a dish of water. Note the behaviour of the floating needles.

Page 138

The activity suggested on this page introduces the children to the idea of terrestrial magnetism. Do not suspend the magnet near iron radiators or pipes because these will influence the magnet. Patience is needed because the magnets will twist and untwist for some time before coming to rest.

It is essential that light twine or heavy thread be used to suspend the magnets because the magnetic force is not great enough to twist heavier twine.

After the pupils have observed that the magnets all come to rest in approximately the same position each time, they may be told that the earth has two magnetic poles and that these magnets are pointing toward them. The magnetic poles should be located on a globe. The North magnetic pole is off the northern coast of Canada, far north of Hudson Bay. The South magnetic pole is in Antarctica.

Pages 139–140–141

Magnetic compasses may now be shown to the pupils. Let them see how the needle comes to rest in a north-south position. Hold a bar magnet near a compass and note the behaviour of the compass needle. Caution the children about holding the magnet against the compass case lest the needle have its magnetic properties changed. The magnet should never be held closer to the compass than is necessary to see a reaction of the needle.

The pupils may now make compasses according to the directions given on page 140. The floating needle demonstrated on page 137 will also serve as a compass. If the children want the points of their needles to point north they must stroke them with the S-pole of a bar magnet.

After the children are acquainted with compasses teach them how to find the directions. Have the pupils determine north, south, east, and west in the room. Direct them to make signs and mark the four walls of the room accordingly.

Take them outdoors and ask them to determine the directions. Take advantage of local features such as "South Hill" and "South Main Street" to help the pupils to learn their directions.

Further work with directions can be done by laying a large map of the region on the floor with the north side of the map facing north. Do not hang the map on the wall. Then find nearby towns and cities and point toward their real locations across the map.

Pages 142–143

A horseshoe magnet may be shown to have two poles by putting it on a layer of iron filings. The filings indicate the location of the poles.

The nature of the poles can be determined by either of the methods shown on page 142. The pole of the horseshoe magnet that repels the N pole of a bar magnet or compass is the N pole of the horseshoe magnet. Mark the poles with coloured chalk or crayons.

The activity on page 143 introduces in an elementary way the principle behind certain electric motors in which a rotating magnetic field causes another magnet to rotate. Before letting the pupils try this experiment, caution them to keep their compasses an inch or more from the magnets.

Page 144

The natural magnet, lodestone, is magnetite, an ore of iron. It is interesting both for itself and historically, because early knowledge of magnets came from experiments with this rock.

Summary Questions

1. Bar magnets always have at least two poles.

2. The filings arrange themselves in patterns with the filings trying to group themselves over the poles of the magnet.

3. A magnet may be made by stroking a bar of steel with the pole of a magnet, as on page 134.

4. Two S poles push each other.

5. Two N poles also push each other.

6. A compass is a magnetized needle placed so that it can move freely. It points out the north-south directions.

7. Magnets pick up things made of iron; there are a few other substances that magnets will pick up, namely, magnetite, cobalt, and nickel.

Follow-up

If the magnets are placed on a small table with proper equipment, the pupils can repeat some of the more interesting experiments. This represents a desirable form of follow-up.

The work on compass directions may be followed up at numerous times when the class is dealing with local geography.

POSSIBLE LEARNINGS

Magnets have several shapes.

Magnets usually have two poles.

Magnetic forces are strongest at the poles.

There are two kinds of poles; a magnet has one of each.

Like poles push each other; unlike poles attract each other.

A freely-swinging magnet comes to rest in a north-south position.

A compass contains a freely-swinging magnet.

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A Boy's Book of Magnetism. Raymond Yates. Musson: Toronto, 1941. 166 pages.

Gives clear directions for tricks and games with magnets.

Magnets. Bertha Parker. Copp Clark: Toronto, 1944. 35 pages.

A brief description of magnets.

Films

North, South, East and West. Jam Handy.

Magnets. Young America Films.

Nature and behaviour of magnets; polarity.

Muddy Water

PURPOSE OF THE UNIT

Constant as the flow of streams and rivers, the process of stream erosion goes on. We rarely notice it, save when some flood or cloudburst radically alters a minor feature of the landscape. But when we look about us we see that every hill, valley, lake, and river shows the effect of long-continued, powerful erosive forces.

Stream erosion is important to us. Agricultural experts have become increasingly aware of the inestimable value of our soil and the appalling loss of this soil through the action of running water. They demand a programme of education that will acquaint everyone with the need for conservation of one of our greatest natural resources.

Third-grade pupils are too young to make any decisions regarding soil conservation but they are not too young to begin the study of stream erosion. Later units will continue to build on the experiences gained at this level. Perhaps some day our future citizens will make intelligent decisions because of the work we do here.

This unit cuts across the areas of geology and conservation, and it reaches also into the area of interrelationships. It is commonplace to deal with the effect of organisms on each other and with the effect of the physical environment on organisms. But in this unit we deal with the effect of organisms upon their physical environment.

PREPARING FOR THE UNIT

The best time to introduce this unit is when spring rains turn our streams a rich brown, when water from melting snow digs miniature canyons across ploughed fields. It is then that the out-of-doors becomes a laboratory for the study of erosion.

However, there may be other seasons that fit the local situation better. A construction project may lay bare a mass of earth that shows the effect of erosion after every rain. It would be unfortunate indeed if this opportunity were wasted. Remember that a good science programme is flexible; it should be designed to permit one to take advantage of situations that arise unexpectedly.

Few materials are needed. The experiments call for some tin cans and a screw-capped glass jar. Not called for but helpful for this unit, is a hose and nozzle connected to an outside faucet.

List of Materials

Glass jars with screw caps
Metal cans
Water pail
Sand
Garden soil

TEACHING THE UNIT

The concepts dealt with in this unit cannot be satisfactorily developed by talk or pictures alone. It is a unit that demands experiments, demonstrations, and field observations. Fortunately, the experiments and demonstrations are simple to perform, and no special equipment is needed. Happily, too, there are examples of the erosive effect of running water near almost every school.

Try to introduce the unit with a reference to some local situations —a trip to study a muddy stream, a trip to see water from a recent rain cutting into a field or pile of loose soil, or perhaps a reference to something the children may have seen on their way to school.

Page 145

This page can be used to introduce the unit if there is no local event such as a flood or high water. Begin with a discussion of the picture. **Is the water running or standing still? How can you tell? Which way is it running? How can you tell?**

Does the water in the creek look like the water you drink? In what way is it different? What gives it its colour? Would you like to drink it?

Near many schools there are streams that become muddy in spring. A trip to see a stream in this condition is desirable. Ask the children to determine which way the water is running. See if they know where the water goes and, if not, provide them with maps after they return to school so that they can find out. **Is the water higher at the time of our visit than at other times? How do you know? Is it flowing faster? Is it muddier?**

Dip up a glass jug full of water. Note its colour. Note any particles in it. Take it back to school and let it stand for several days. Sometimes a thin film of mud will settle out, especially if the water has been taken near the bottom of a stream where the heavier sediments are carried.

Pages 146–147

The experiment suggested here helps to show that moving water picks up soil. It is the soil that has been picked up that turns the water brown. To make this experiment more effective, let the two jars stand for a day or two. Most of the soil will settle to the bottom of the jars. Then stir the first jar again and note that the soil is picked up by the moving water.

The next page gives an application of the understanding developed by the experiment just performed. Country children frequently see the conditions pictured here. City children are less likely to see them, although most excavations for buildings, roads, and gravel pits show similar muddy rivulets after heavy rains. The picture on the page may be discussed in terms of the little streams shown,—that there are wide quiet places and narrow swift ones and even little waterfalls, that these little streams are much like big ones. Continue to build up the concept developed on the preceding page, that running water picks up soil.

If possible, take a trip immediately after a rain to see little rivulets of muddy water running across a field or washing down a pile of excavated soil.

Pages 148–149

These pages continue to develop the concept introduced on the preceding pages and broadens it to deal with the effect of the removal of the soil.

The experiment described is a simple one but very effective. It is even more effective if a hose with a nozzle can be used. Then a larger pile of soil can be used, and with the nozzle set for a fine spray to simulate rain, larger streams with more erosion will result. If the school does not have a hose or a place where soil may be heaped up, perhaps someone in a nearby home will let the experiment be performed in an unplanted garden.

Following the experiment, we have (on page 149) an application of the principle that has been developed. The children may study first the picture, comparing it with their observations of the experiment. Then, if possible, the pupils should be taken to see similar situations outdoors. Remember that small-scale examples make effective teaching situations when there are no examples like the one pictured. Almost every construction site will serve after a heavy rain—this may be a cellar excavation, a new embankment, a freshly-excavated gravel pit, a new lawn, or a terrace.

When discussing the observations that the children have made, turn their attention to possible effects that are harmful, particularly to the farmer whose fields are affected.

Pages 150–151

These are picture-study pages that show what often happens if water is allowed to flow unchecked through a gully. In some regions there are many examples of different stages of gully formation which the class may visit or which the children may see on their way to and from school.

Pictures of gully formation are common in magazines and publications of conservation agencies. These make good bulletin board displays.

Pages 152–153

Page 152 suggests activities that show some of the effects of plants on the soil. They may be carried out on a small scale in a sand table or large pan. They may also be carried out on a larger scale outdoors.

The effectiveness of grass roots in holding soil is effectively demonstrated by trying to wash the soil from a piece of sod. Even a swift stream of water from a hose fails to dislodge all the soil, so tightly do the rootlets of the plants hold it.

Page 154

Tree roots help to hold the soil but they are less effective than grass roots because they do not make a network so close to the surface. However, in a wood there are additional aids—the mat of dead leaves and twigs that fall from the trees.

A trip to a woodlot to examine the soil cover is worth while. Dig down through the litter to discover its thickness. Study the composition of the litter. Note the meshwork of roots under the litter. Look for examples of gully formation in the woods. Look for trees that have blown over and note the way the roots have held the soil.

Take back some of the litter and experiment with its ability to reduce the loss of soil, possibly repeating the experiment on page 152.

Page 155

Reforestation of steep hillsides to reduce erosion is a common project in some areas. This page shows the method of hand planting; machines do this work on bigger projects. If a reforestation project has been carried out in the neighbourhood, try to visit it. In discussion of reforestation mention some of the secondary effects of such reforestation—water holding, source of timber, reduction of wind speed, home for animals, and places for recreation.

Pages 156–157

These are discussion pages that summarize the work of the unit. The children should be able to tell why there is more erosion on the bare field than on the grass-covered field near it. They should be able to tell why the water in the one stream is muddier than in the other. They should also have some idea of which situation is more desirable from the standpoint of people.

Page 158

This simple experiment is added to start the pupils wondering about the fate of the soil that is washed from a field. Later units develop this area more thoroughly. Ask the children to look for the soil that has been washed from a field or an excavated bank.

Summary Questions

1. A stream becomes muddy because its water has been running over soil that is not protected by plants or some other means.
2. A bare field may have little streams of water run over it during a rain, especially if the field is on a hillside. These streams will dig gullies in the soil.
3. The gully continues to grow deeper and wider with every rain.
4. The grass leaves and stems break the force of the falling raindrops and the roots cling to the soil.
5. The principle reason for planting trees on hillsides is to help to hold the soil. The children should be made conscious of some of the secondary reasons for reforestation mentioned in the discussion of page 155.
6. Farmers need rich soil for their crops; they do not want their rich soil washed away.

Follow-up

The children should be kept on the alert for evidences of erosion and if an unusual example develops, the class should be taken on a trip to see it. Call the children's attention to evidences of erosion noticed even on trips taken for other purposes.

New pictures of erosion may be encountered and these should be posted long enough for the children to look at them. Sometimes such pictures merit a few minutes of discussion.

POSSIBLE LEARNINGS

Soil in water makes it muddy.
Running water picks up soil.
Running water digs gullies in soil.
Plants help to keep soil from being washed away.
We sometimes plant trees to help to hold soil.

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Books

Audubon Nature Bulletins. National Audubon Society, New York. 4 pages each.

Several of the bulletins contain background information to supplement this unit. List sent by the Society on request.

Audubon Teacher's Guide. National Audubon Society, New York, 1948. 90 pages.

This is a teacher's guide to activities and source material.

Cornell Rural School Leaflets. Cornell University. Thomas Allen: Toronto.

The leaflets contain background material and information on almost every science topic. Consult the list of titles.

First Book of Water. Josephine and Ernest Norling. Ambassador Books: Toronto, 1952. 45 pages.

Water as a traveller and its work. Water as fun.

Films

The Muddy Raindrops. Society for Visual Education.

SN-135 Meaning of Conservation. Ontario Department of Education.

How our country's resources and natural beauty are maintained by building dams, planting trees and limiting hunting and fishing.

Toads and Frogs

PURPOSE OF THE UNIT

Toads and frogs are especially interesting inhabitants of our wild areas. Members of the group called amphibians, they pass through startling changes in body form. They exist first as fish-like creatures and end up as quadrupeds. In earlier study we learned that birds and mammals make transformations before birth. As we study toads and frogs we see this change take place before our eyes. Thus we continue the sequence already initiated in the unit "Birds' Eggs" in *Exploring Science Two.*

This unit is essentially one of reproduction and sex education. The terms "male" and "female" are introduced, the presence of the male at the breeding ground is established, and the extrusion of the egg mass by the female is mentioned. Unfortunately, propriety insists that reproduction is a purely female function whenever it is referred to at all. But teachers have here an opportunity to mention that the male deposits something that makes the eggs develop. Later units on flowers and fish will expand this idea further.

In this unit children learn the part that frogs and toads play in their environment—how they feed upon insects and other small animals, and how they are in turn fed upon by larger animals. This tends to promote an unsentimental but sympathetic understanding of the problems of living things—affording a true basis for conservation and humaneness.

Throughout the unit the teacher should insist on kind treatment for the animals being studied. Frogs and toads brought in for observation should be released as soon as possible, except perhaps for one that is kept in suitable surroundings and fed adequately. Likewise, only a small quantity of eggs should be gathered, and the tadpoles should be given proper food and suitable water conditions.

PREPARING FOR THE UNIT

Used alone, the material in this book represents only picture study, a poor substitute for good science teaching. But used with living eggs, tadpoles, and adults, this book suggests procedures, directs observations, and gives supplementary information; it then represents a high form of education.

Fortunately, living materials are usually close at hand. Toads are widely distributed; their eggs may be found in shallow, temporary pools almost everywhere during early spring. The eggs of other species may be used also. For instance, the wood frog lays large, conspicuous masses of floating eggs early in the season. These are frequently brought in by children.

Sometimes teachers do not know where to look for eggs and their pupils have never found them. But in almost every community there are people who are interested in nature and who are willing to be of help. Older children are also valuable assistants.

Desirable equipment includes that necessary for collecting and keeping the living material needed for teaching the unit. Eggs can be collected in glass jars that have screw tops. They may be kept in clear glass fish bowls or in gallon jars such as paste jars. Wire strainers of the kitchen variety are useful in collecting tadpoles. A rectangular aquarium, which need not hold water, can be used to set up a habitat for an adult frog or toad; fit it with a pane of glass over the top.

List of Materials

Glass jars with screw caps
Large aquarium or terrarium with glass cover
Kitchen strainer
Hand lenses
Paste jars

TEACHING THE UNIT

This is an informal unit that may be taken up in any order. Although it begins with a study of the toad, the unit could begin with a study of the frog or the tree frog. Life histories of these forms are so similar that the story of the toad, studied from the pictures, can be applied directly to whatever species is available for study.

The words "male" and "female" are introduced in this unit. Discussion about their meanings should attend their introduction. Explain that the word "male" applies to people and animals who are or who may become fathers; boys and men are males, bulls are males. The children may suggest other examples. The word "female" can then be treated in the same way.

Page 159

Use this picture as a basis for a discussion to bring out past experiences of the pupils. The children can describe what they have seen toads do, where they have seen them, and what they know about the habits of toads.

The myth regarding warts will certainly crop up; it should not be treated lightly as some people recommend. Rather, people who have handled toads should have their hands examined for warts, and those who have warts should be questioned as to whether they have handled toads before they had warts. It is rare that any relationship between the two will be suspected from the evidence.

Page 160

The page begins a story of the toad, but as stated before, other common species have similar life histories.

The mating calls of one or more species are well known in many regions. The spring peeper, for instance, is a favourite harbinger of spring within its range. Some of these animals are most active by night and their calls are rarely heard during school hours. But the toad may be heard sounding its beautiful trill at almost any time of day when the weather grows warm.

The teacher will find an evening trip to see these creatures singing a most unusual experience. The light of a flashlight does not seem to bother them and they continue singing. After the teacher has taken such a night trip she may wish to take small groups of children. Parents will co-operate on such trips, using their cars and helping with the supervision. Be sure that the children are dressed warmly and that they wear boots or high overshoes.

Spring peepers, and perhaps other species, will sing when kept in a suitable terrarium in the classroom. There are also recordings of the songs of toads, frogs, and tree frogs, some of which are native to most regions of the country. (See BIBLIOGRAPHY)

Page 161

Toads lay their eggs in strings, most frogs lay theirs in masses, and tree frogs usually lay theirs singly. If the children find masses of eggs, explain this difference.

Sometimes, on a trip, the children may see a male mounted on a female and clasping her tightly. Explain to the pupils that the male puts something on the eggs as they come from the female; explain that this process (known as fertilization) is necessary for the eggs to develop. (The close-up of the toad egg here shows jelly round it.)

Page 162

We now suggest that eggs be brought into the classroom if none have been brought in before. Note that only a few should be collected and that a large container is used. The water may be the same as that in which the eggs were laid. If tap water must be used, let it stand for a day or so to get rid of any chlorine in it.

Keep the aquarium in the coolest part of the room. Cool water absorbs and holds more oxygen from the air than warm water does. The developing eggs and the young tadpoles need oxygen.

Pages 163–164–165

These pages show the development of the little tadpoles. Most members of this group of amphibians follow a similar pattern of tadpole development. The children will follow the process with high interest. They should be encouraged to tell what they have seen, to write about, and to make sketches of, their observations.

Some eggs may not hatch. These have died in the early stages. Some may have died because of a fungus infection. Others may not have been fertilized by the male. Explain these possibilities.

Page 166

Tadpoles are essentially vegetarians and scavengers. They will do well in an aquarium on the sides of which there is a dense growth of green algae—the slimy, green coating that develops so rapidly when the aquarium is exposed to light. The tadpoles may also be fed small amounts of fish food and an occasional speck of meat. Be careful, however, not to put in so much food that some of it spoils and pollutes the water.

Page 167

It is likely that tadpoles raised from eggs will not develop into adults in an aquarium. Perhaps the food or the lack of sunlight or both are responsible. To show the change to adults, collect a few large tadpoles including some that have already started to develop legs. These tadpoles will probably continue to develop. This page shows five stages in the transformation of a tadpole to a fully-developed young toad, with the early stages drawn larger in proportion for clarity.

The aquarium in which developing tadpoles are kept must have something on which the animals can crawl to get out of the water. As soon as the tadpoles start using their lungs they must take their air from the surface. If they cannot crawl from the water they will tire from trying to support themselves by swimming and will drown. A slanting board or a large rock will serve.

Pages 168–169

The feeding habits of a toad or frog are interesting. The animal may be kept in a terrarium like that described on page 174. Live flies released in the terrarium provide it with food. Sooner or later one of these flies will come near the toad and suddenly disappear. It is also amusing to watch the toad eat a live fishworm, stuffing the dangling ends in with first one front foot and then the other. Remember that the toad will eat only things it sees in motion—not dead food.

The toad eats many small living things, but is not itself eaten by many animals. Back of the toad's eyes are two wart-like glands. These glands secrete a poison that discourages many animals from eating the toad, although snakes are not affected by the poison. Frogs do not have this protection.

Pages 170–171

The life history of frogs is much the same as that of the toads. The picture shows the life history of a common frog—a leopard frog.

Frogs, without the protection afforded toads, are eaten by many animals. Many birds of prey feed upon them. The wading birds (like the great blue heron on page 171), the hawks, even owls, have been known to eat them. Large fish such as bass, pike, and trout eat frogs. Snakes of several kinds eat them. Large frogs eat smaller frogs. Many meat-eating mammals such as raccoons and foxes eat them. Man eats them too, killing the large frogs for their hind legs.

Page 172–173

Tree frogs are less well known than their relatives, the frogs and toads. However, they are common and they are generally very noisy during their breeding seasons. Being smaller, and living as they do in trees and bushes, they escape general notice.

All toads, frogs, and tree frogs possess the ability to change colour to some degree. Tree frogs can undergo some marked changes, the common tree frog being noted for the variety of its colours. The tree frog on page 173 is shown (top to bottom) on an aspen tree, birch tree, and on an ash tree.

Try some experiments with colour changes. The wood frog, the spring peeper, and the common tree toad are good subjects. Put the animal in a glass jar which contains a little water to keep the humidity high, and move the jar to various places. Put it in a dark closet, then put it on white paper in the light. The changes need an hour or more for completion.

Page 174

A rectangular aquarium makes a suitable terrarium for a frog or toad. The aquarium can be one that is cracked or leaks; it does not need to hold water. A glass pane over the top helps to keep the air inside moist. The edges of the glass cover should be covered with adhesive tape or with gummed tape so that a pupil is not cut by them.

It is possible to keep a toad or frog in such a terrarium through the winter, provided that a supply of food is available. As mentioned previously, the frog or toad eats only moving food: live flies and fishworms are satisfactory. Sometimes toads and frogs become inactive for short periods indoors, but the greater warmth tends to keep them active.

Summary Questions

1. Toads lay their eggs in water, usually in shallow pools.
2. Toad eggs are laid in strings of jelly. Other amphibian eggs are laid singly or in masses.
3. Visible changes include: loss of tail, development of four legs, increase in the size of the eye and shift of its location, change in coloration, change in body shape, development of "warts," poison glands, and "ears," change from gill breathing to lung breathing, and change in food habits. (See page 167.)
4. Tadpoles eat tiny living things and dead materials in water. Toads eat larger animals such as earthworms and flies.
5. Tree frogs have sticky pads on their toes; toads and frogs do not.

Follow-up

After the main body of the unit has been studied, the children will like to continue their observations of the living animals they have collected. They may also bring in other forms for study. Perhaps some of these animals will also be observed on other trips and may be discussed briefly in terms of what has been studied.

POSSIBLE LEARNINGS

Toads, frogs, and tree frogs lay eggs in the water.
Females lay the eggs.
Tadpoles develop from the eggs.
Tadpoles are adapted for a life in water.
Tadpoles undergo some remarkable changes as they become adults.
The adults are essentially air-living forms, although a few species continue to find some protection in the water.
The adults feed on smaller animals and are fed upon by larger animals.

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Several of the bulletins contain background information to supplement this unit. List sent by the Society on request.

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The leaflets contain background material and information on almost every science topic. Consult the list of titles.

Frogs and Toads. Herbert Zim. George J. McLeod: Toronto, 1954. 64 pages.

A scientific picture book giving beginnings, development, and history.

Handbook of Nature Study. Anna Botsford Comstock. Thomas Allen: Toronto, 1947 ed.

Valuable for general reference and as a teaching guide. An up-to-date natural history library in one volume.

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The development from tadpole to bullfrog, in narrative and photographs.

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Pond Life. Encyclopaedia Britannica Films. Ontario Department of Education: SB-8.

Shows animals that live upon one another and keep the population of the pond in balance.

The Frog. Encyclopaedia Britannica Films. Ontario Department of Education: SN-31.

Life cycle of the frog including some excellent slow-motion photography.

Grass

PURPOSE OF THE UNIT

One of the basic concepts to be developed in a science programme is that living things depend upon each other and upon their physical environment. The grasses are a widespread and important group of plants that play a dominating part in the lives of many animals and other plants. Man has come to be so dependent upon grasses that he would be hard-put to survive were they to disappear. By studying some of the simpler relations between grasses and man and between grasses and a few wild animals, pupils cannot help but grasp something of the importance of living forms to each other.

Activities involving the planting of the seeds of various grasses help in an understanding of the reproduction of common plants and the ways in which they are considered to be related. The idea of food storage in the seed receives much emphasis in this unit.

PREPARING FOR THE UNIT

The unit may be introduced any time in the spring after the grass starts to grow. It is also possible to use it in early fall by shifting the order of units.

A few simple materials are needed for some of the activities. These should be collected or located beforehand so that they will be available when the activities are to be carried out.

One of the instructive and interesting activities is the making of wheat flour. For this a handful of wheat is needed; this may be obtained at a feed store or a pet store. The text shows (page 184) how a round stone and a flat stone can be used to grind it. The flour may be sifted from the bran with a clean handkerchief or similar piece of cloth.

Several grains are called for, specifically oats and corn. To these should be added others of importance such as rice, barley, rye, and the lawn grasses. These may be put on display. Some of each may be planted.

Seeds of other grasses may be used for exhibits and for planting. Many of these are sold in seed stores. Bird seed, too, is made up largely of grass seeds.

Glass jars, drinking glasses, metal cans, and flower pots are needed for planting grass seeds as directed in some of the activities.

List of Materials

Glass jars
Tin cans
Flower pots
Garden soil
Grains of corn, oats, wheat, and other grass seeds as desired
Seeds of peas, beans, and other garden plants
Drinking glasses
Blotters or paper towels
Flat stone and a round stone
Grater
Hammer
Clean handkerchief

TEACHING THE UNIT

This is a fairly compact unit which may be taught in a short space of time. It permits numerous activities and field observations.

At the beginning, the term "grass" refers to plants which the pupils usually think of as belonging to this group—the lawn and pasture grasses. Soon, however, it is broadened to include those that botanists consider grasses—the cereals, such as wheat and corn. The pupils may need some help in making this adjustment of their thinking.

Page 175

Centre a discussion around the grass in this picture. **What are the cattle doing? What are they feeding on? Where is grass growing?**

Turn the discussion to grass around the school. **Is there grass growing near the school? Where? Where are some places that the grass is not growing?**

Where is there grass growing at your homes? Where does the grass fail to grow around your homes? Where have you seen other places that have no grass?

The pupils will probably conclude that grass grows over a very large part of the countryside, except in the middle of densely populated cities, in thick woods, and perhaps in desert regions if their experiences include such situations. Actually, there are few places where grasses do not grow in Canada.

Pages 176–177

These pages attempt to establish the importance of grasses to man. The children can expand the work on grass-eating animals by making a study of cuts of meat, the leather and wool industries, and the dairy industry.

The use of grasses for lawns is not usually thought of as important, but a little consideration will show that it is. People gain much satisfaction from the grass around their homes and in parks; lawn grass is pleasing to the eye, it keeps the soil from becoming hot in summer, and it prevents the soil from becoming dusty and blowing about.

Many games are played upon grass and the children will certainly think of games that they themselves play such as croquet. Depending upon their experience, they will think of such other games as baseball and golf.

Pages 178–179

The activities described on these pages are designed to help the pupils to gain a knowledge of how some common grasses grow, and why we consider the cereals to be grasses. Seeds may be planted in tin cans, flower pots, ice cream containers, or waxed paper cups. Be sure that there are always holes in the containers so that excess water can drain off. Label each container with the name of the kind of seed planted. Try lawn grasses, pasture grasses, and grasses used for hay. Try bird seed. Plant some of the cereal grains also. For comparison, plant the seeds of plants that you know are not grasses, such as peas and beans.

The grasses send up slender spears with single leaves. Other common seeds, however, will send up stems bearing two small leaflets. Call the attention of the children to these important differences.

The purpose of planting some of the seeds in drinking glasses as shown on page 179 is to give the children an opportunity to watch the development of the stem, leaves, and roots. Try several different species, including some that are not grasses.

Pages 180–181

The parts of a grass plant are illustrated here. Bring in some different kinds of grass plants and locate the parts. The flowers are interesting to study with a hand lens.

Many grasses send out underground stems (or root-stalks) that produce new plants at intervals. Such plants are troublesome in gardens because each part of a broken stem becomes a new plant. On the other hand, some species are more valuable for lawns and pastures because of this habit.

The children will discover that grasses grow from points along the stem rather than from the tips of the stems or branches as so many other plants grow. They will be able to understand why grasses can often be clipped off and still survive. Most other plants are killed or stunted if their growing regions are cut off. Of course, as indicated in the text, some grasses can stand closer clipping than others.

Page 182

Here are some common cereals, all members of the grass family. Provide samples of each for the children to look at. The children may then study the cultivation of these species and the production of edible foods from them. They may collect or draw pictures to show the uses of these seeds.

Page 183

Making "rolled" oats by this process is a simple operation. The product is similar to the kind packaged for sale except that the latter is usually cooked to some extent before being sold.

Corn meal can be made with a grater if some dry corn on the ear can be obtained. Corn flour can be made by grinding the grains in the manner described on the following pages for grinding wheat flour.

Pages 184–185

These pages describe a method of making wheat flour by one of the most primitive processes. If stones of the type indicated are not available, one may crack the grains with a hammer and grind them in a mortar of the sort that chemistry teachers have.

Following this activity, the pupils may be interested in studying the methods by which flour is made today.

Pages 186–187

Grass is very important in the lives of most wild animals. Here are shown some ways that birds make use of grass. A bobwhite, goldfinch, and meadow lark are shown—top to bottom. The children should be able to name many insects and mammals that use grass in one or more ways.

Meadow mice feed extensively on grass, almost unsuspected by the average person. Sometimes, when they are numerous, they may seriously reduce the amount of grass in a pasture. They eat the new growth during all seasons, including winter when grasses may grow on warmer days. They also eat the seeds, and on page 187 is shown a method by which a meadow mouse is able to make a meal on the seed head of timothy—a tall-growing grass.

Page 188

The production of hay is big business in some parts of the country. Where this is true, give due attention to the process and to the use of the hay. Hay-making used to be a simple process of drying ripe grass stems. Today grass is usually cut green and there are many different methods of treating it. Rural children will know the processes used locally and can describe them adequately.

Summary Questions

1. The children should name the common domestic animals shown on page 176 and such wild animals as they know about.
2. The children will know the cereal grasses by name; they may know some of the lawn, pasture, and hay grasses.
3. The children will be able to name numerous foods made from different flours and from rice, and they will know of many breakfast foods made from cereals.
4. Grass plants have long leaves ribbed from end to end, and they grow from certain places along the stems.
5. Wild animals use grasses for shelter, for hiding-places, and for food.
6. Wheat flour is made by crushing the grains and sifting out the coarser outer parts of the grains.
7. We plant lawns for beauty, to keep the air cooler in hot weather, and to hold down the dust.

Follow-up

Continued study of the plants growing in the classroom and related plants growing outdoors should be encouraged. Trips to see various grasses being planted or harvested may be possible in some localities. The children may re-seed worn places in the school lawn and try to prevent heavy traffic over corners of the school lawn until the grasses have become re-established. They may also continue their studies of the economic uses of the various grasses. Corn, for instance, is used in a remarkable number of ways in industry.

POSSIBLE LEARNINGS

Many animals feed upon grass.
We depend directly and indirectly upon grass for most of our food.
Grasses grow in many places.
We use grasses for lawns.
We eat the seeds of many grasses.
Wild animals use grasses in many ways.

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Interesting background information for the teacher.

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Handbook of Nature Study. Anna Botsford Comstock. Thomas Allen: Toronto, 1947 ed. 937 pages.

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A book about the larger grass-eating animals.

Film

SA-3 *Dairy Farm.* Ontario Department of Education.

The economic and social importance of the dairy farm is portrayed by a visit to a typical Midwest farm. We see the farmer engaged in his chores.

List of Science Materials

(Class of Thirty Pupils)

NUMBER	ITEM	REMARKS
2–15	hand lenses	Low power. Needed in every grade
2–15	kitchen strainers	Can be used in nearly every grade
2–15	household thermometers	Needed in nearly in every grade
2–15	small mirrors	Pocketbook size
2–15	bar magnets	At least four inches long
1–2	large horseshoe magnets	The stronger the better
2–15	magnetic compasses	
1 box	iron filings	
1	flashlight	A picture projector can be used instead
1	lamp chimney	Type sold for kerosene lamps
1	aquarium or terrarium	Need not be watertight
1	pane of glass	To fit on above aquarium
1	fish bowl or large jar	A gallon paste jar will serve
1	electric hot-plate	Or other source of heat
1	fire extinguisher	To keep in room during experiments with fire
1	medicine dropper	
1–6	hammers	
2–15	scissors	
1–6	side-cutting pliers	
1	spade or spading fork	
1	yardstick	
15–30	candles	Large candles such as plumbers' candles
2	metal pans	About a foot in diameter
1	pane of glass	To cover one of the above pans
1	water pail	Large pan can be used

NUMBER	ITEM	REMARKS
	glass jars	Assorted sizes of mayonnaise jars
	milk bottles	Assorted sizes
	tin cans	Assorted sizes
2–4	drinking glasses	Clear glass
	"wind-up" toys	May be borrowed from pupils
	alarm clock	May be borrowed
	mousetrap	
30 sheets	Bristol board or other thin cardboard	For megaphones, at least 18 inches square
2	cellophane bags	
	paper fasteners	
	wire	
	nails	Large ones for axles of spools
	tacks	Large carpet tacks
	matches	
	string	
	thread	
	rubber bands	
	pieces of cloth	
	tennis ball or baseball	Should be white
	empty spools	
	scraps of lumber	
	wire coat hangers	
	sand	
	garden soil	
	pot for plants	
2	coleus plants	
1	pumpkin	For jack-o'-lantern
	wheat, oats, rye, barley, and corn grains	Samples from a feed store
	seeds of peas, corn, beans, radishes, lawn grass	Samples from a feed store

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Excellent general reference on common plants and animals, together with sound teaching suggestions.

Man in Structure and Function. Fritz Kahn. McClelland and Stewart: Toronto, 1943.

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A practical book with descriptions of appropriate activities including photographs and drawings and carefully prepared lists of source material.

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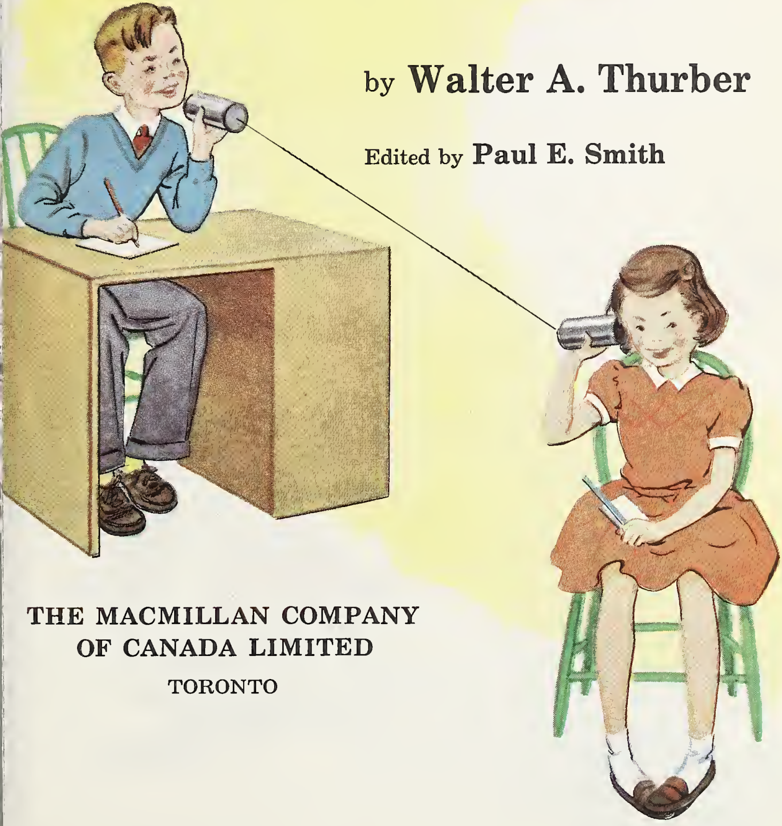

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Edited by **Paul E. Smith**

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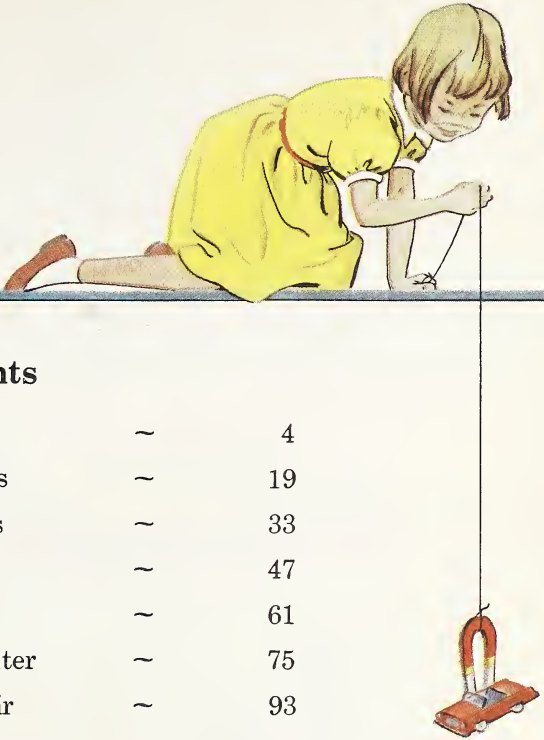

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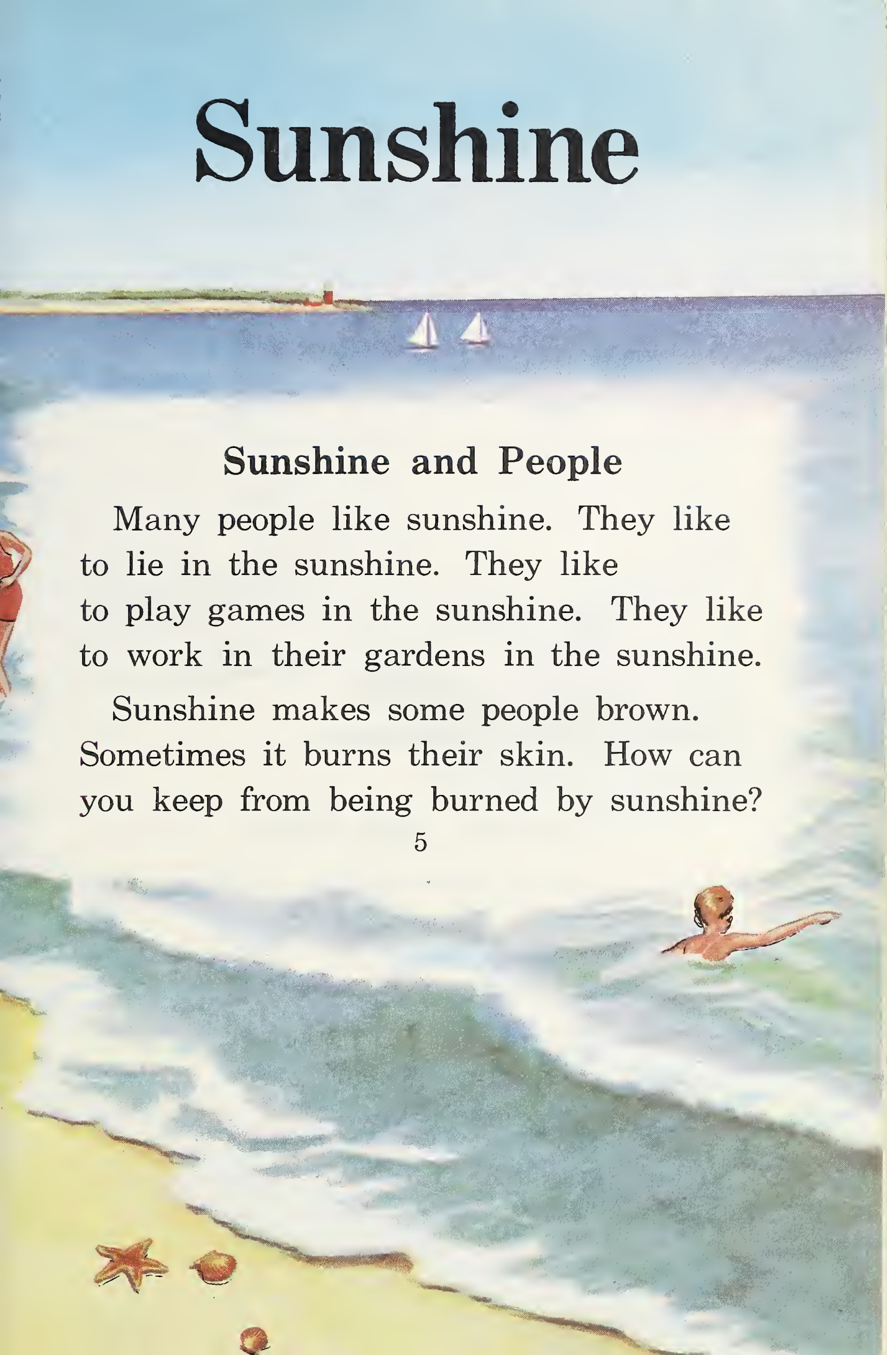
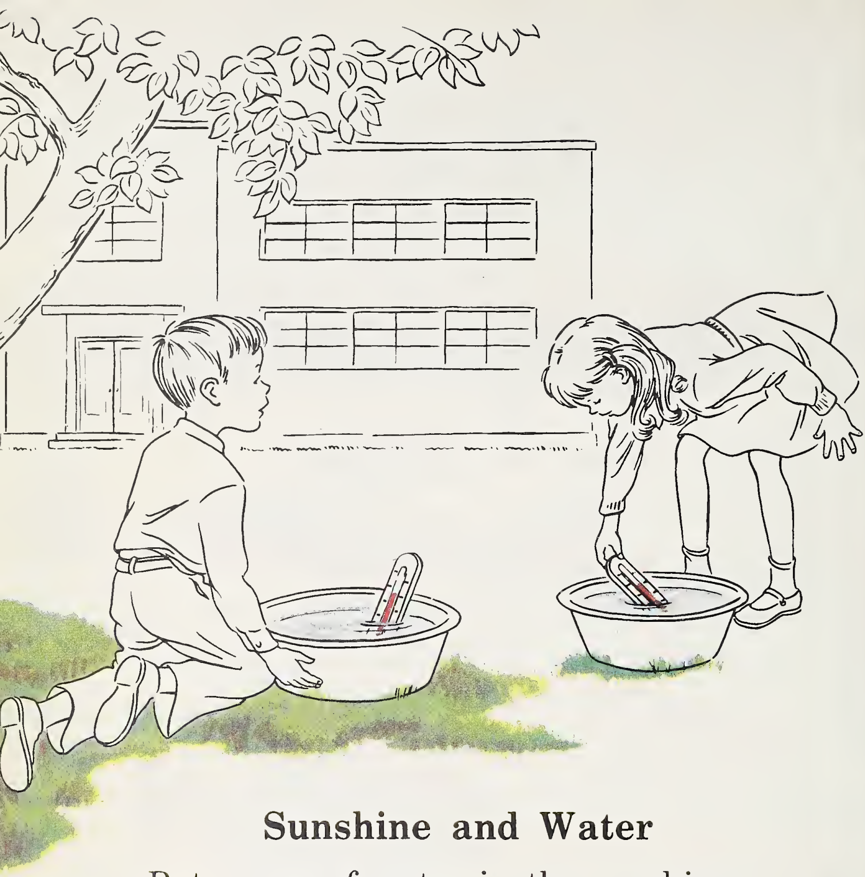


Sunshine

Sunshine and People

Many people like sunshine. They like to lie in the sunshine. They like to play games in the sunshine. They like to work in their gardens in the sunshine.

Sunshine makes some people brown. Sometimes it burns their skin. How can you keep from being burned by sunshine?



Sunshine and Water

Put a pan of water in the sunshine.
Put a pan of water in the shade.

Take the temperature of the water in each pan.

Take the temperature again an hour later.

What happened?

Sunshine and Sand

Put a pan of sand in sunlight.
Put a pan of sand in shade.

Take the temperature in each pan.
Take the temperature an hour later.

What happens?

Sunshine and Animals

Some animals like the sunshine.
They like it best on cool days.
The sunshine makes them warm.

Do your pets lie in the sunshine on cool days?

Some animals do not like sunshine on hot days.

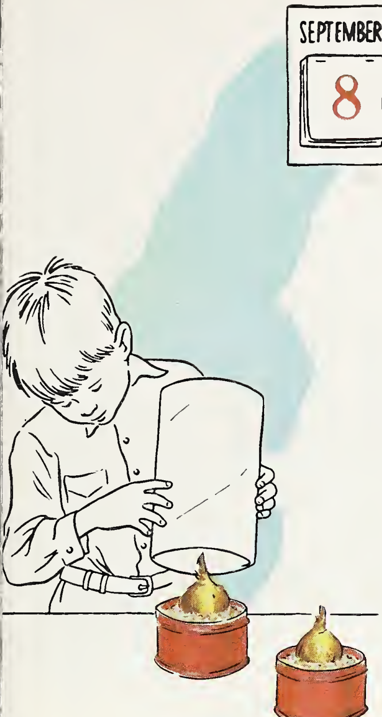
Why do they lie in the shade on hot days?

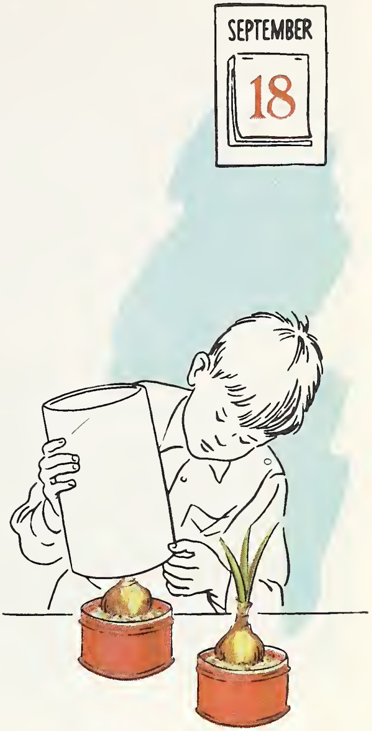
Where does your dog lie on hot days?

What do people use for shade on hot days?

Sunshine and Plants

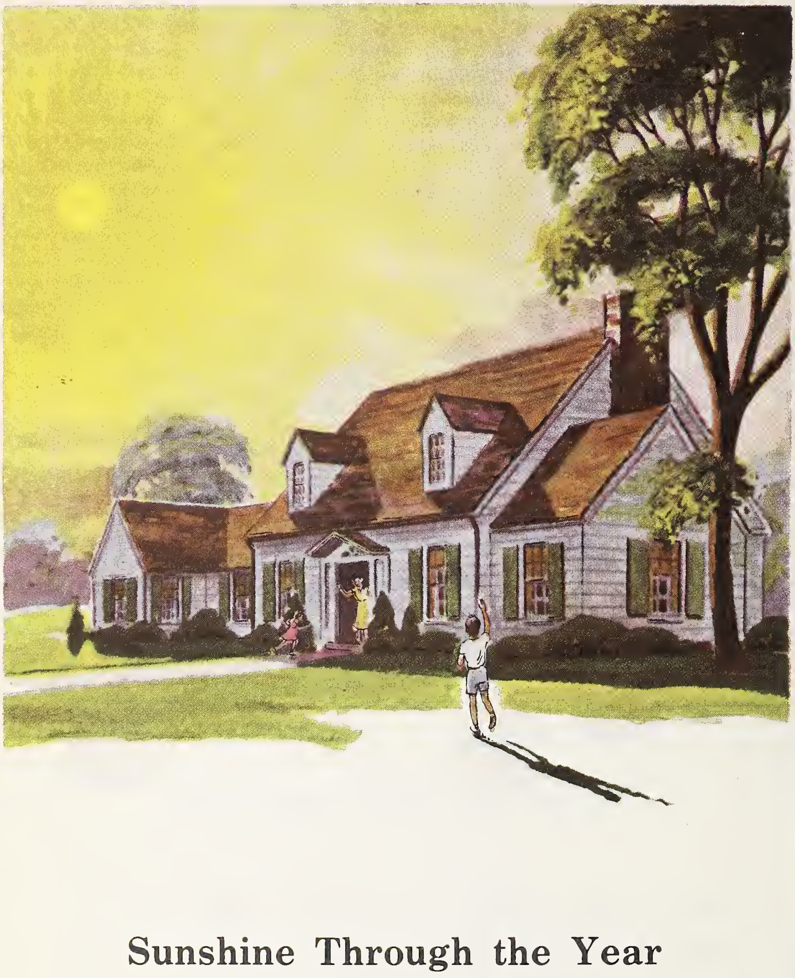
Put two plants in a window.
Watch them for several days.
Which way do the leaves turn?
Turn one plant halfway around.
Watch it for several days.
What happens?





Plant two bulbs.
Water both bulbs.
Keep a box over one bulb.

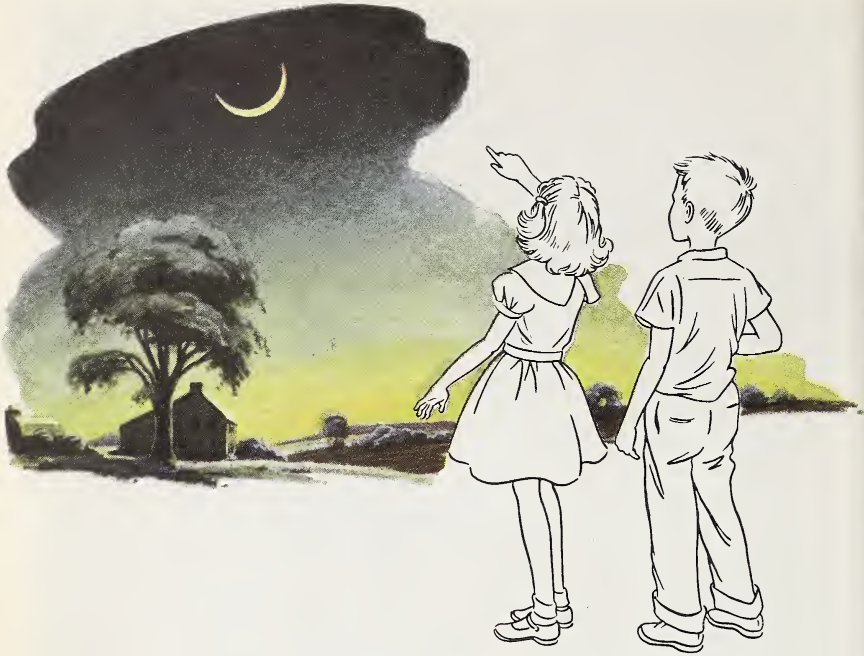
Look at the plants every day.
What happens to the plants?



Sunshine Through the Year

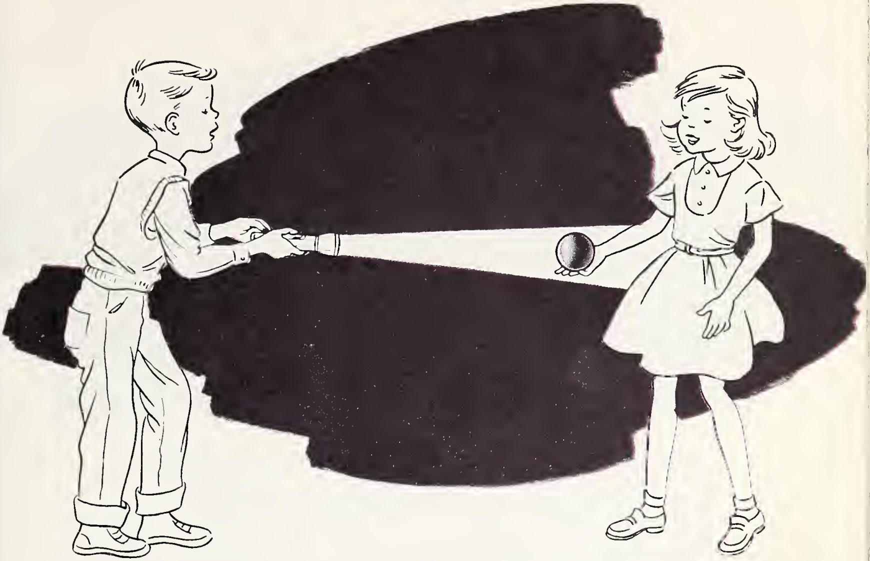
This is supper time on a summer day.
What can the children do after supper?
Where is the sun at breakfast time?

This is supper time on a winter day.
What can the children do after supper?
Where is the sun at breakfast time?
Is there more sunshine in summer or in winter?



Sunshine on the Moon

Sometimes the moon looks like this.
Sometimes it looks round.
The moon is like a very big ball.
Sunshine on it makes it light.
The part toward the sun is lighted.
The part not toward the sun is dark.
You cannot see the dark part.



You can use a ball
to show why the moon is light.

Make the room as dark as you can.

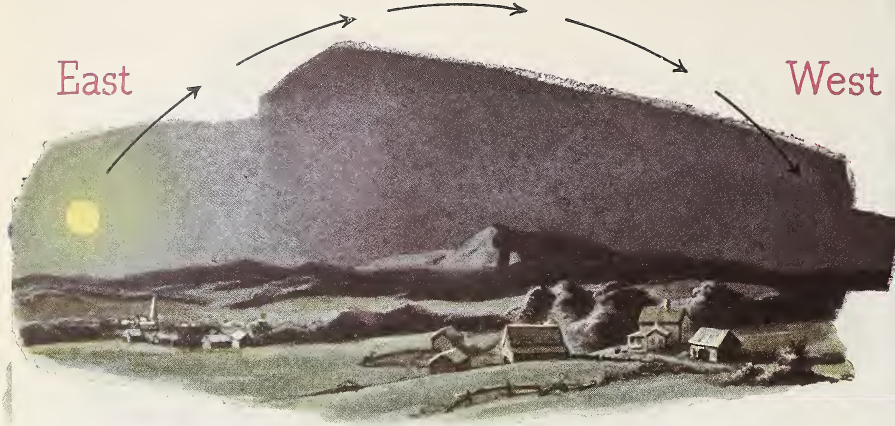
Ask someone to shine a flashlight
on the ball.

Part of the ball will be lighted.

It reflects light to you.

The moon reflects sunlight.

You should think of moonlight
as reflected sunlight.



Watch the moon for several nights.

Some nights you will see it appear in the east.

Some nights you will see it disappear in the west.

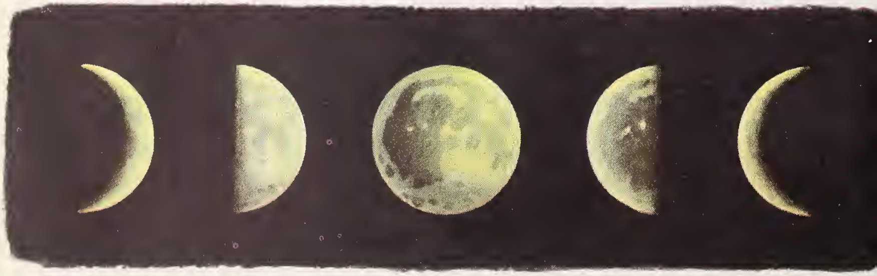
The moon seems to move across the sky.

The moon does not always look the same.

Sometimes it looks round.

Sometimes you see other shapes.

What shapes have you seen?

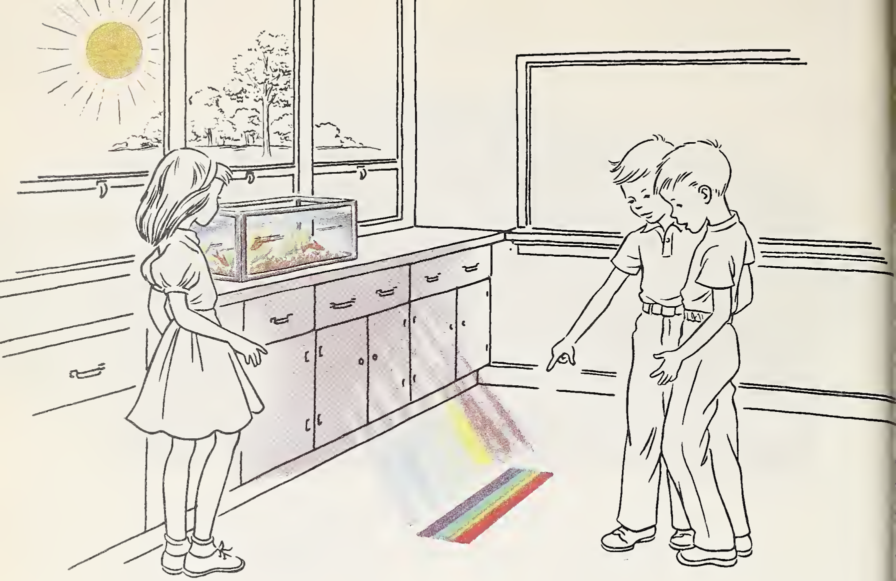


Sometimes
we see sunshine
on the earth.

Sometimes
we see sunshine
on the sky.

Sometimes
we see sunshine
on the moon.

Sometimes
we do not see
any sunshine.

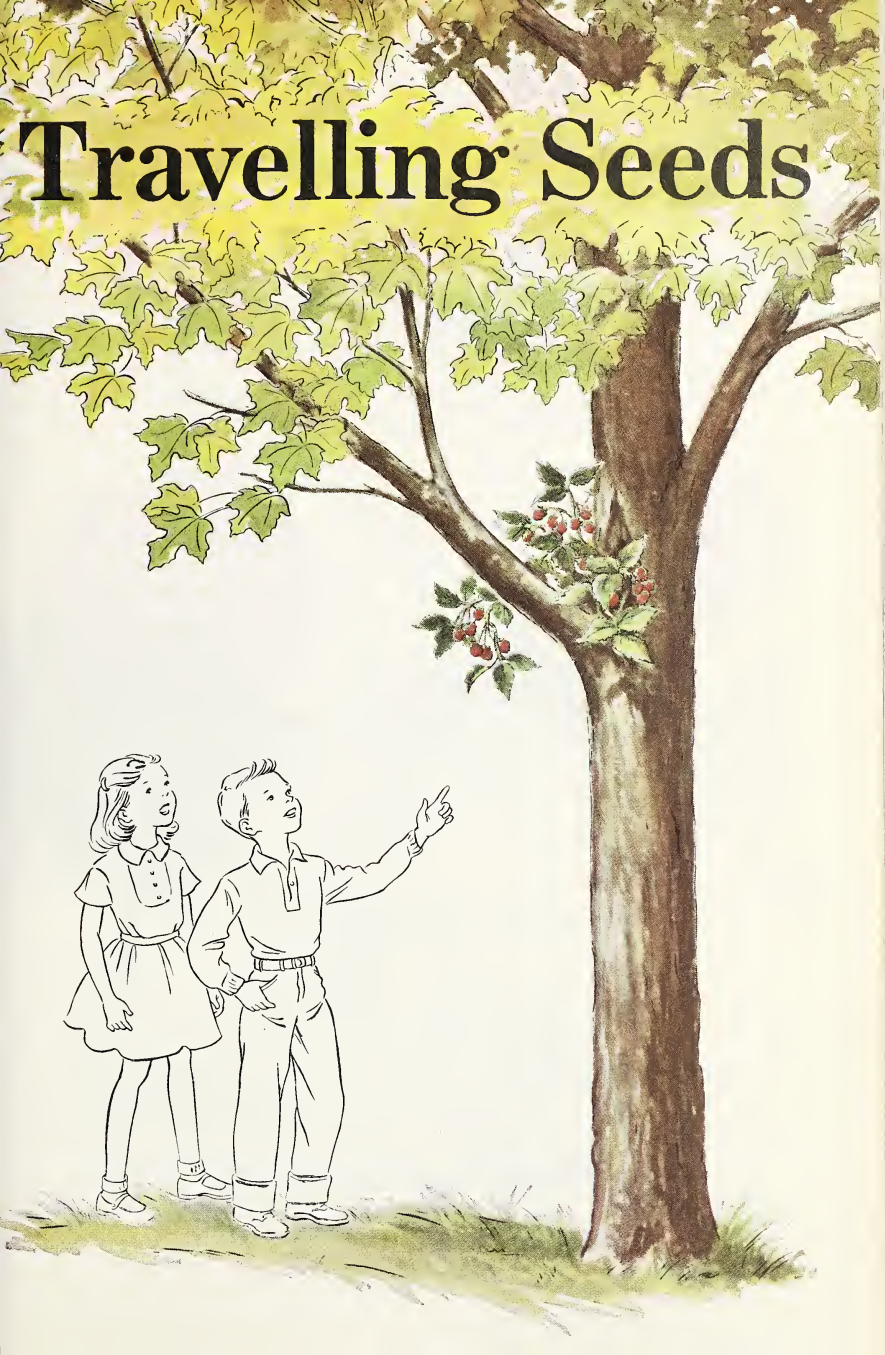


Sunlight has changed into the rainbow colours. What made it change?

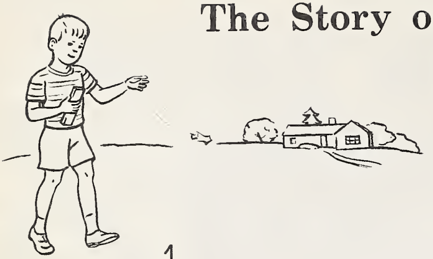
---

1. Name some animals
that like sunshine.
2. How can sunshine harm us?
3. At what time of year
do we have the most sunshine?
4. What is moonlight?
5. How do you know
some plants need light?
6. What does sunshine do to water
and sand?

Travelling Seeds

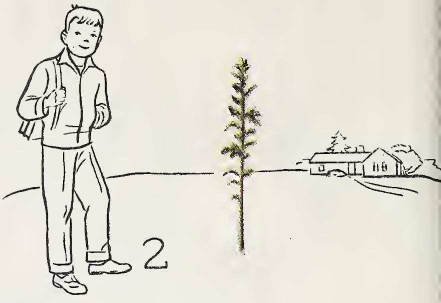


The Story of an Apple Tree



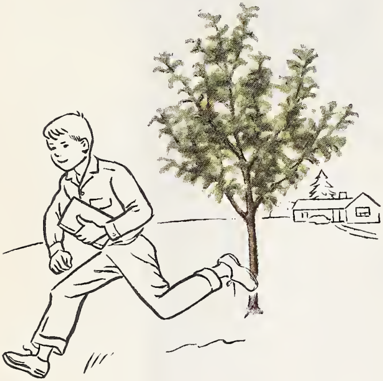
1

This boy is
six years old.



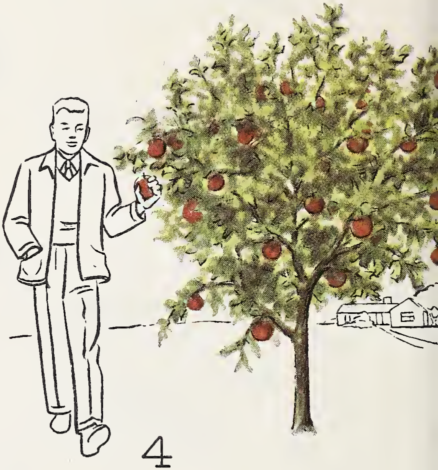
2

Now he is
eight years old.



3

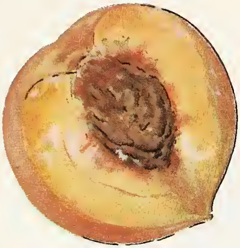
Now he is
ten years old.



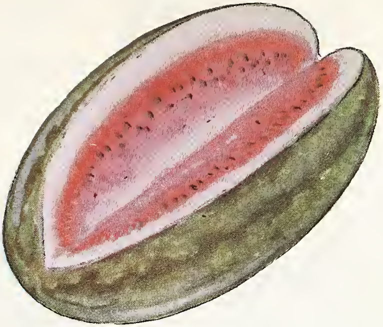
4

Now he is
grown up.

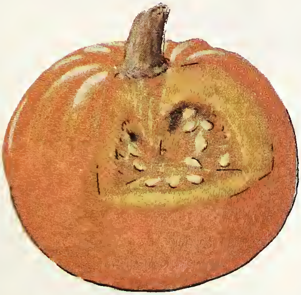
Can you tell this story?



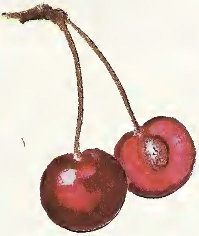
Peach



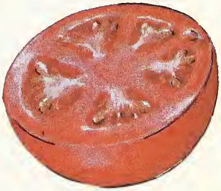
Watermelon



Pumpkin



Cherry



Tomato

Seeds Inside Fruits

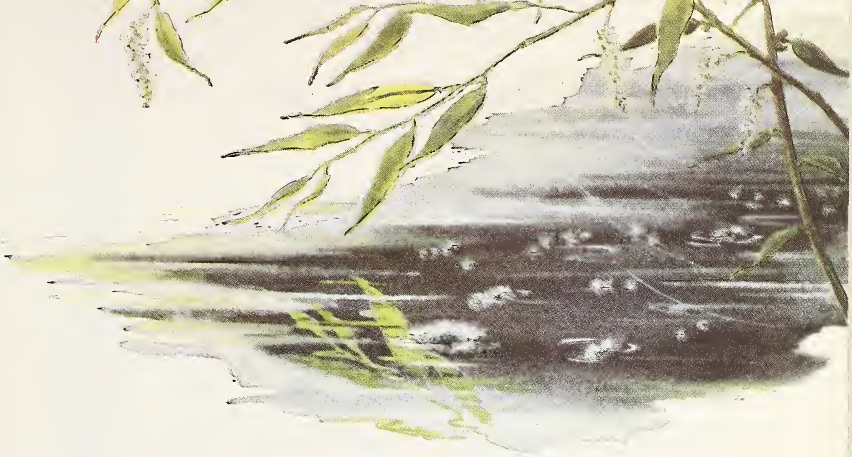
Here are five fruits. What are they?
Find the seeds inside these fruits.

Bring in different kinds of fruits.
Find the seeds inside them.
Which seeds have you seen planted?

Animals Carry Seeds

Squirrels eat acorns and other nuts. They often hide them in the ground.

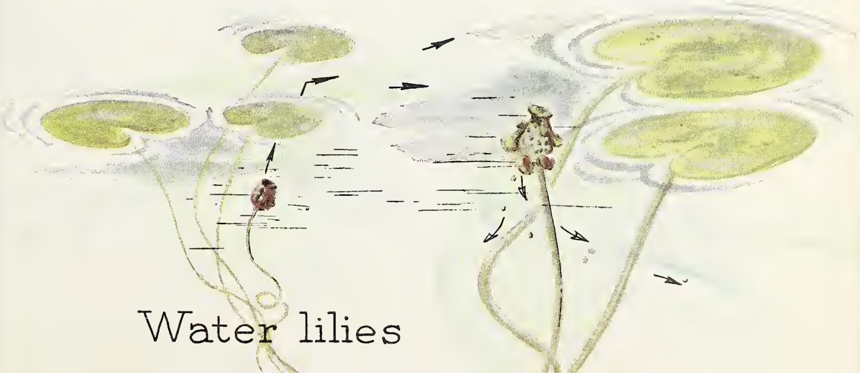
Sometimes they do not find them all. What may happen to the nuts and acorns?



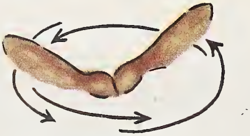
Water Carries Seeds

Seeds often fall in the water.
Streams may carry them many miles.
Sometimes the seeds float to the land and grow.

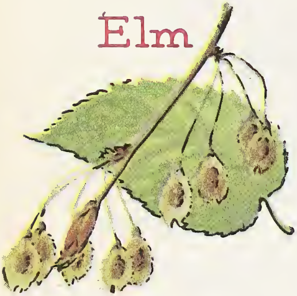
Water lily seeds float in the water.
They float away from the plant.
Soon they drop to the bottom.
Then what may happen to the seeds?



Seeds with Wings



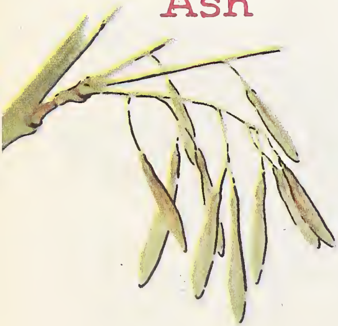
Maple seeds have wings.
This is the way a maple seed falls.

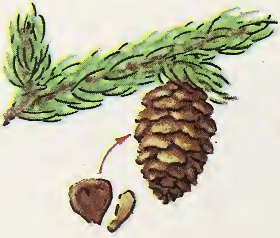


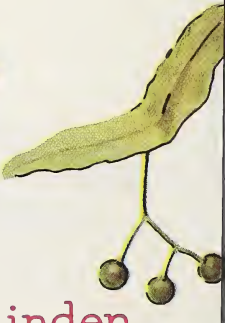
Other trees have seeds with wings.

Seeds with wings cannot fall quickly.

The wind can blow them far away.







Find some seeds with wings.
Drop some from a high place.
Drop some from a low place.
Drop them when the wind is blowing.
Tell what happens.

Other Seeds Blown by the Wind

1

One windy day
Peggy was watching
dandelion seeds.

2

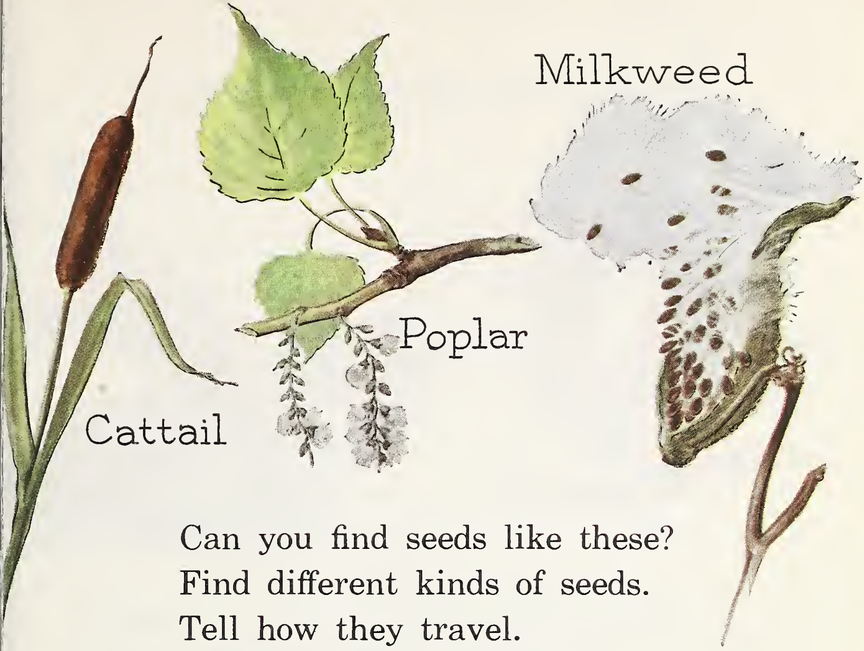
The wind
blew the seeds
far away.

3

One seed fell
in Peggy's garden.

4

Next year
Peggy had
a dandelion
in her garden.



Can you find seeds like these?
Find different kinds of seeds.
Tell how they travel.

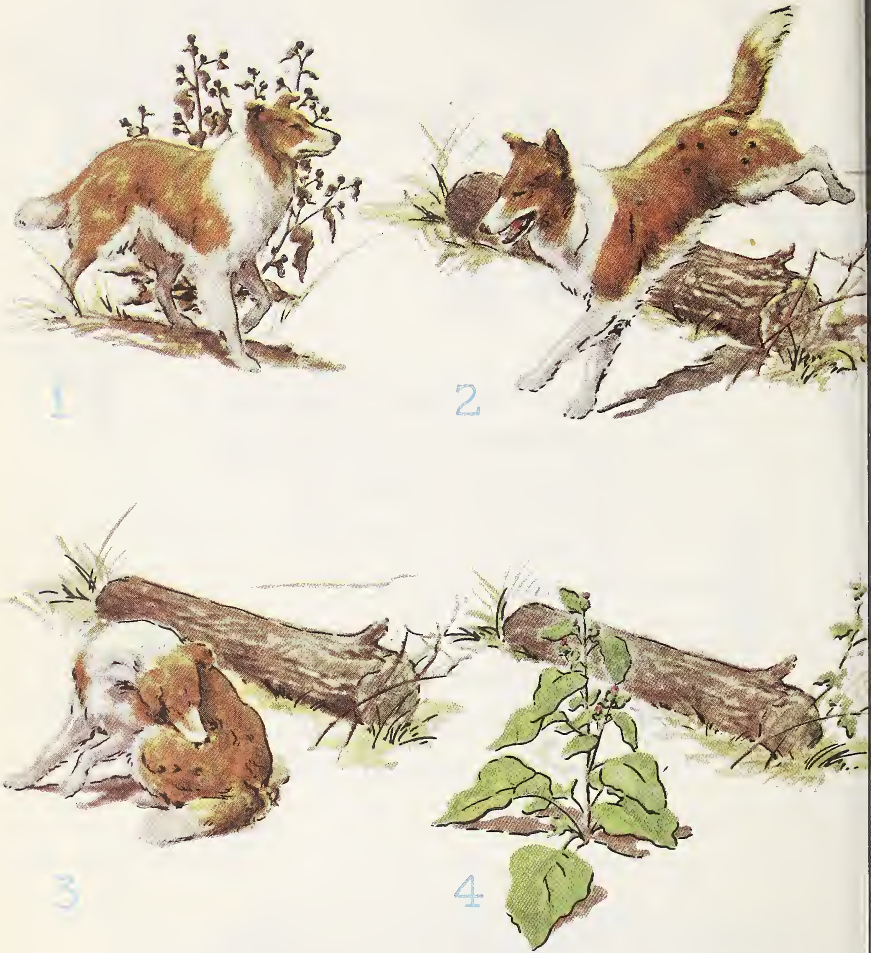
Strong winds break off some kinds of plants.

The wind rolls these plants over the ground.

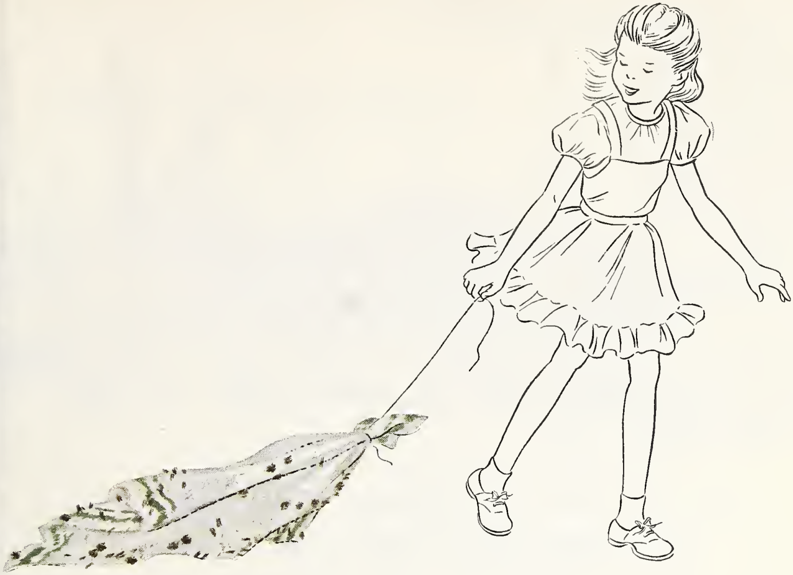
Then the seeds drop off.

They scatter on the ground.

Seeds That Stick to Animals

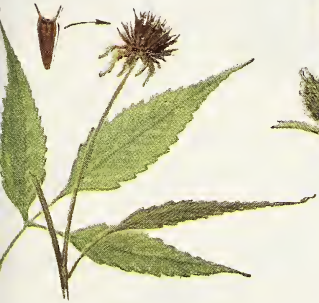


Can you tell this story?

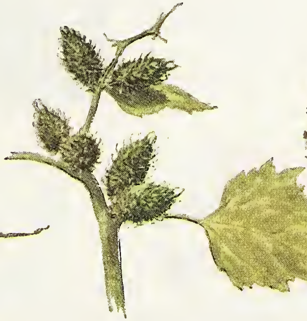


Here is a way to collect some seeds. Tie a woollen cloth to a string. Drag the cloth through some weeds.

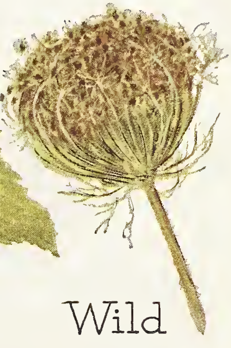
Try to find many kinds of seeds that stick to animals.



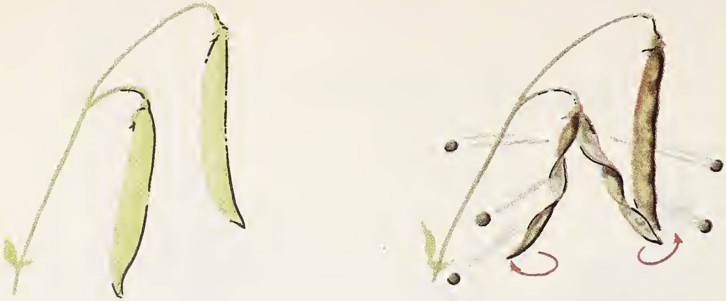
Beggar's ticks



Cockleburs



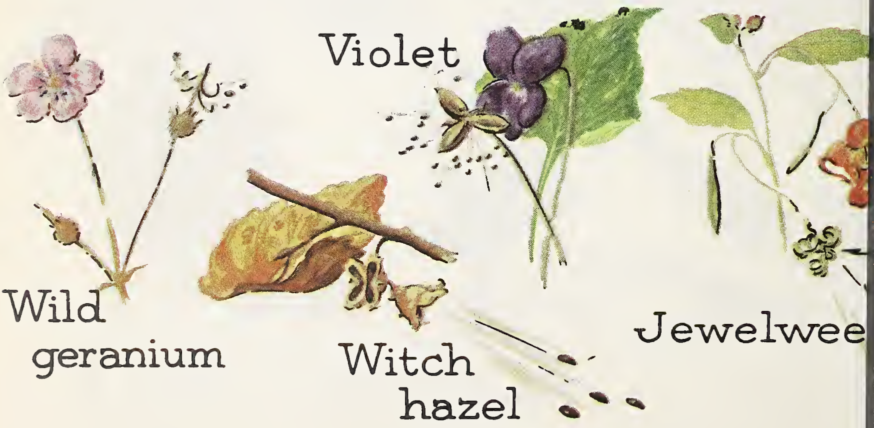
Wild carrot



Plants That Throw Their Seeds

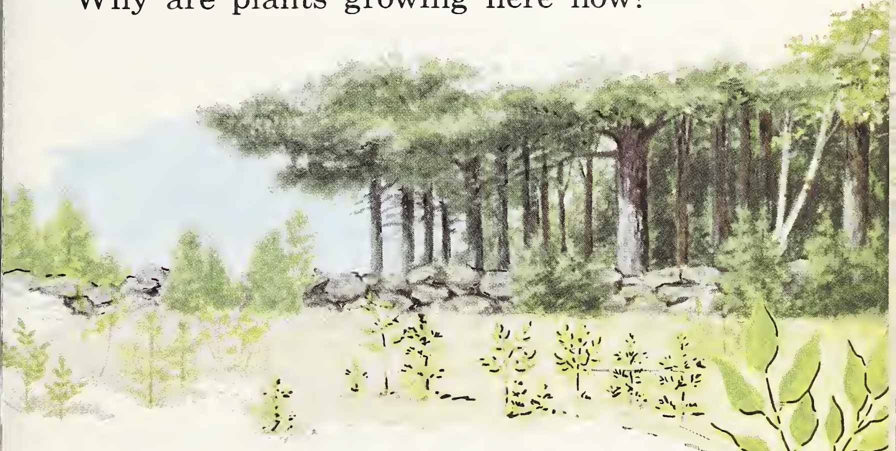
The pods are the fruit
of the sweet pea plants.
The pods break open when they dry.
They throw the peas out.
Peas are seeds of pea plants.

Here are other plants
that throw their seeds.

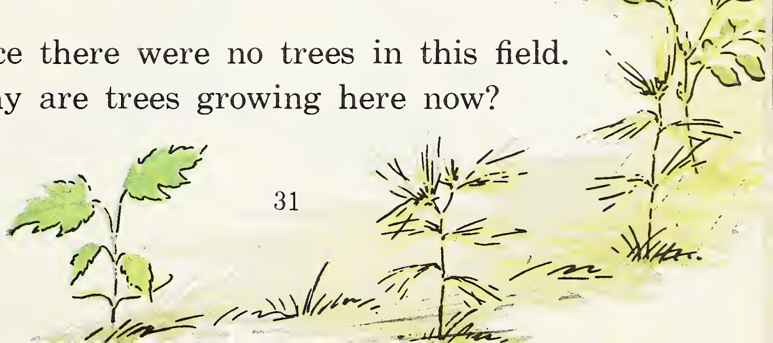


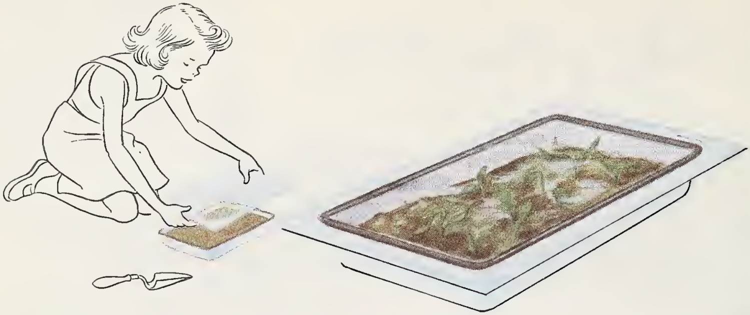
Plants in New Places

This was once a bare lot.
Why are plants growing here now?



Once there were no trees in this field.
Why are trees growing here now?





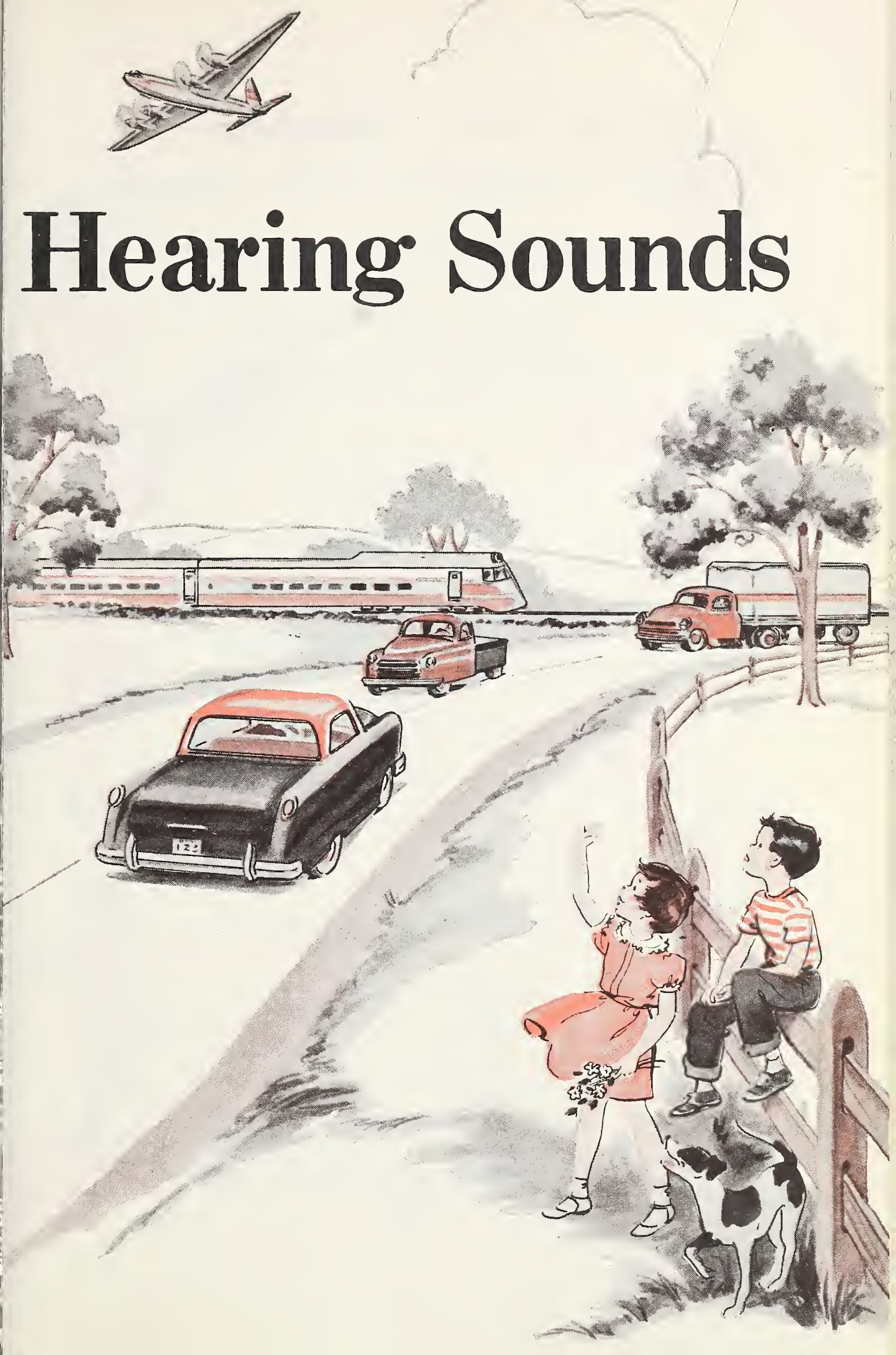
Dig up some soil from a garden. Put the soil in a pan. Cover the pan with a piece of glass.

Watch the soil for several days. Does anything grow from it? Can you tell why there are plants growing?

---

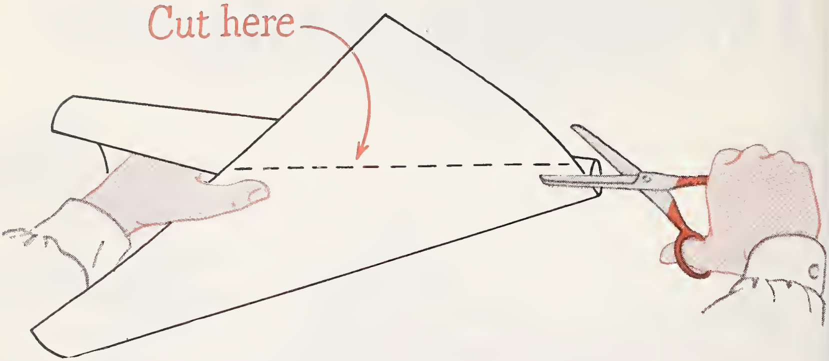
1. What kinds of seeds do squirrels scatter?
2. How do dogs help scatter seeds?
3. What kinds of seeds stick to people's clothing?
4. How are dandelion seeds scattered?
5. How do wings on seeds help scatter them?
6. What are some other ways seeds are scattered?

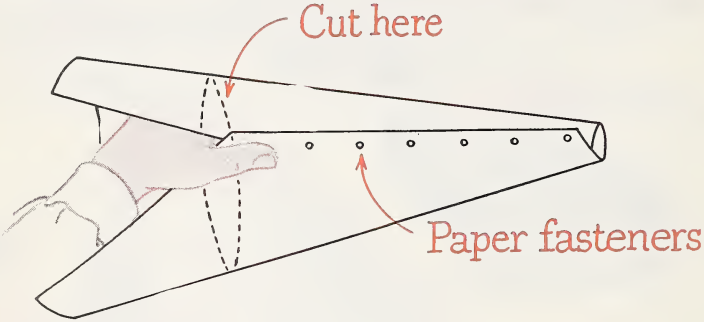
Hearing Sounds

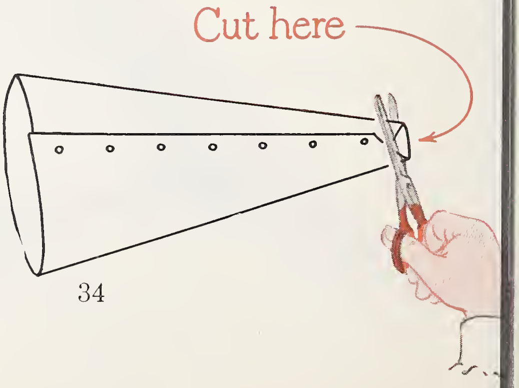


Fun with a Megaphone

Make a megaphone of thin cardboard.







Go outdoors.

Talk to your friends
through your megaphone.

Now talk to them
without the megaphone.

Turn around and talk
through the megaphone.

Which way
can they hear best?

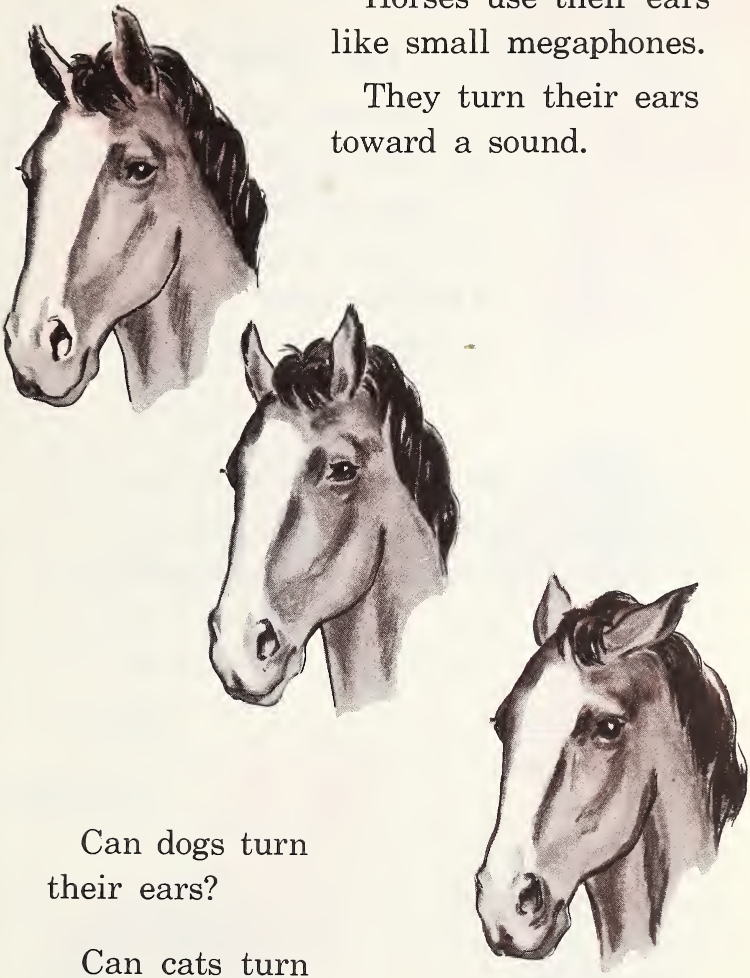
Hearing Sounds Better

Hold the small end
of your megaphone
close to your ear.
Can you hear better
with the megaphone
or without it?

You can make small megaphones with your hands. Hold your hands behind your ears and listen.

Horses use their ears like small megaphones.

They turn their ears toward a sound.



Can dogs turn their ears?

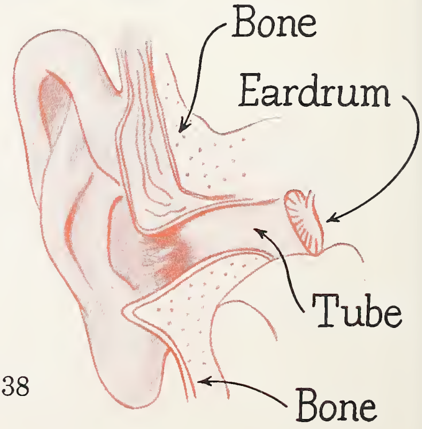
Can cats turn their ears?

Our Own Ears

Our outer ears
are like small megaphones.
A tube carries the sound
into each of our ears.
Find the tube
in someone's ear.

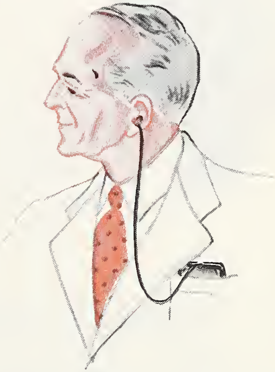
Look into the tube. You will see wax and many small hairs. The wax and the hairs help keep out insects and dirt.

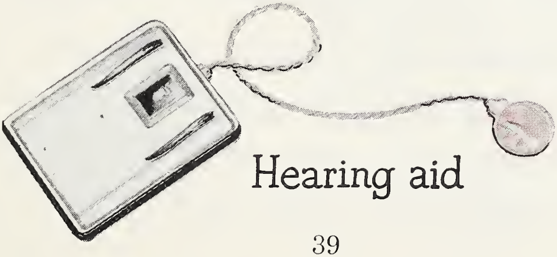
An eardrum
is at the end
of the tube.
You should not
put sharp things
in your ears.
Why not?



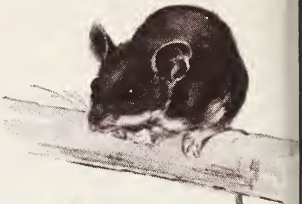
Some people need glasses to see well.

Some people need hearing aids to hear well.





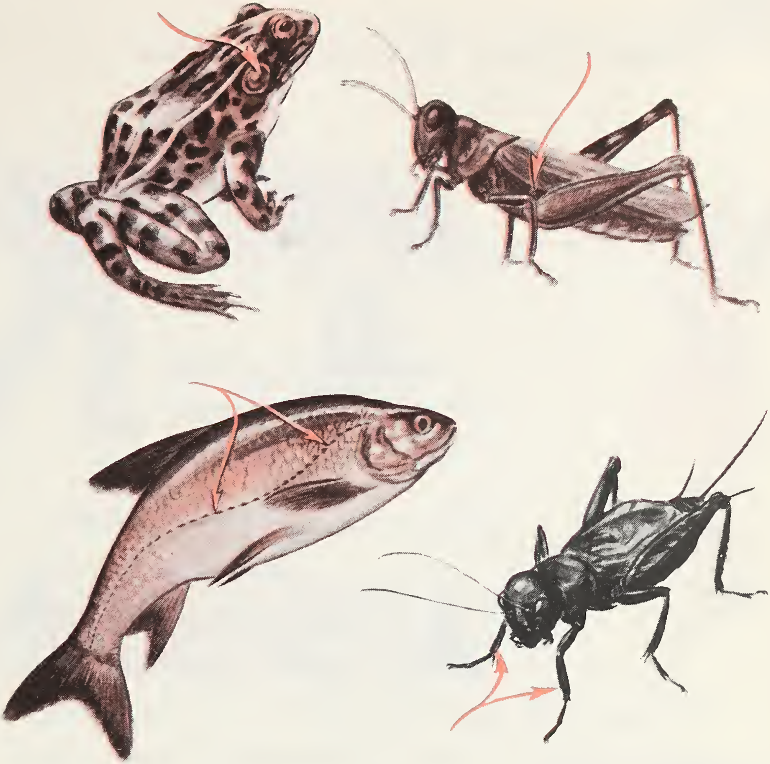
Hearing aid



Animals with Ears Like Ours

These animals have ears like small megaphones. They can hear very well.

Look at the ears of a dog or cat. How are their ears like ours? How are their ears unlike ours?

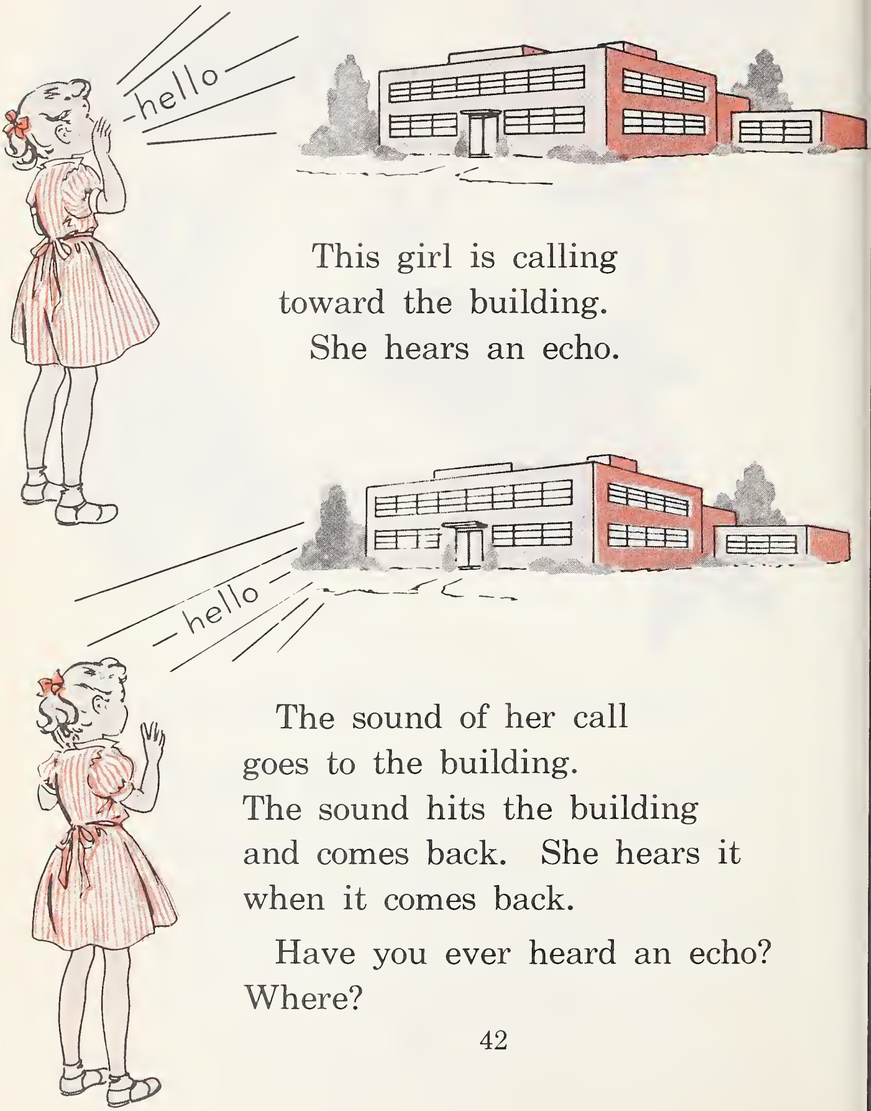


Animals with Ears Not Like Ours

We do not know how these animals hear.

They may hear with the parts marked in the pictures.

Sound Goes Through the Air



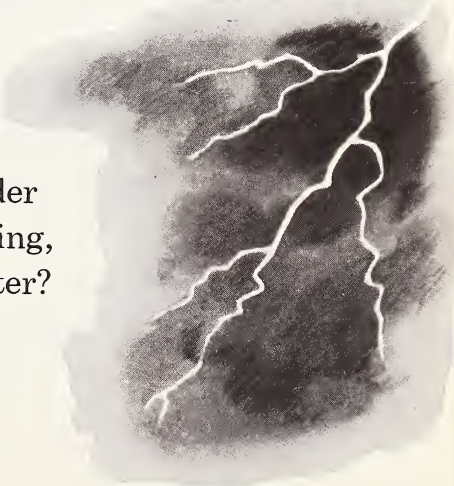
This girl is calling
toward the building.
She hears an echo.

The sound of her call
goes to the building.
The sound hits the building
and comes back. She hears it
when it comes back.

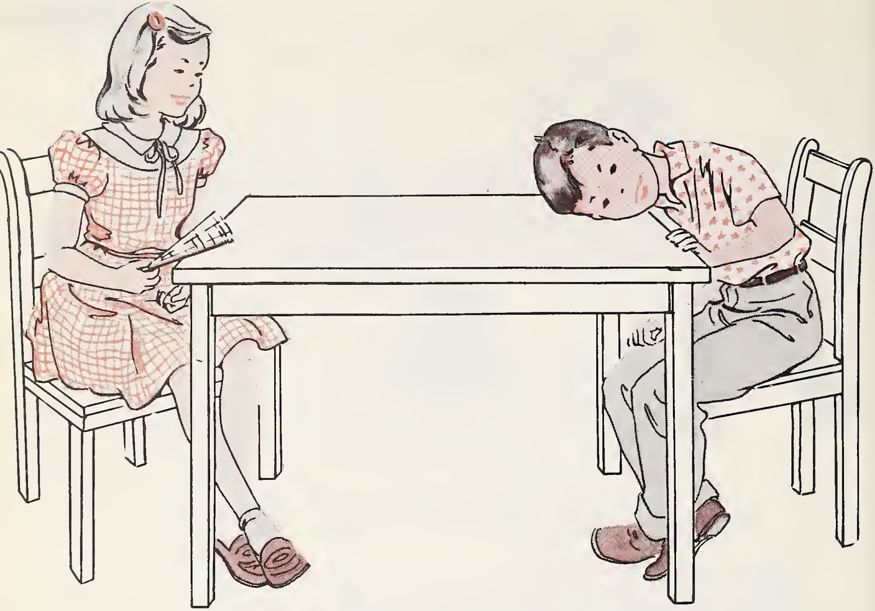
Have you ever heard an echo?
Where?

Sound needs time to travel
through the air.

Ask someone to hit a pail
with a stick. Stand far away
and watch him. You will hear the sound
after you see the stick hit.



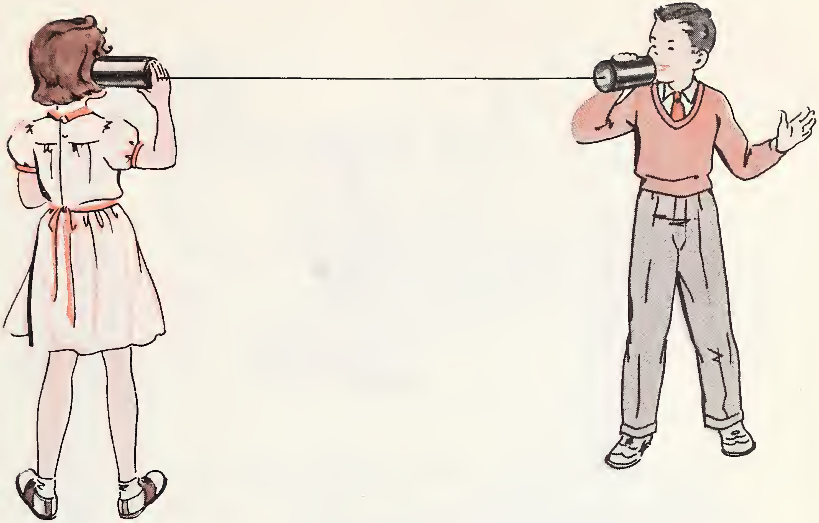
Do you hear thunder
when you see lightning,
or do you hear it later?
Can you tell why?



Sound Goes Through Wood

Lay your ear on a table top.
Ask someone to hit the table
with a pencil. Can you hear
the sound through the wood?

Lift your ear from the table.
Ask your friend to hit the table again.
When was the sound louder?

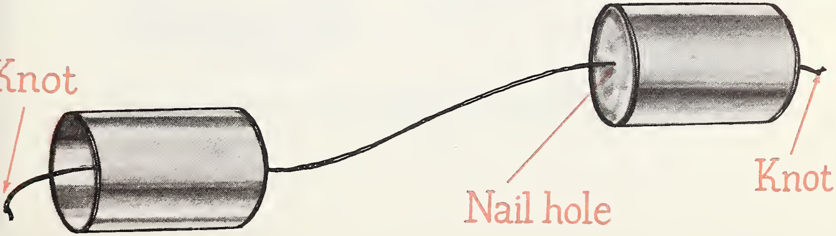


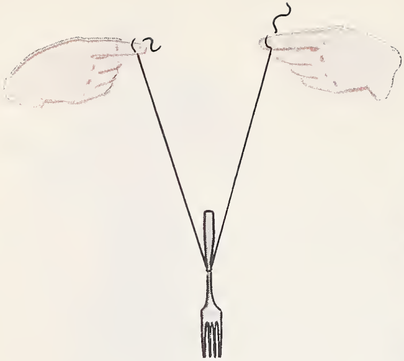
Sound Through String

Make a tin-can telephone.
You will need two cans and a string.

Make a small hole in the bottom of each can. Put the string through the holes and tie a big knot in each end.

Keep the string tight and talk to someone through the telephone.





Tie a fork in the middle of a string. Wind the ends of the string around your fingers. Put your fingers in your ears. Then ask someone to hit the fork with a pencil.

How did the sound go to your ear?

---

1. What can you do to hear sounds better?
2. Why does a horse turn its ears?
3. Why should you keep sharp things from your ears?
4. What is an echo?
5. How do you know sound takes time to travel?
6. Name three things that carry sound.

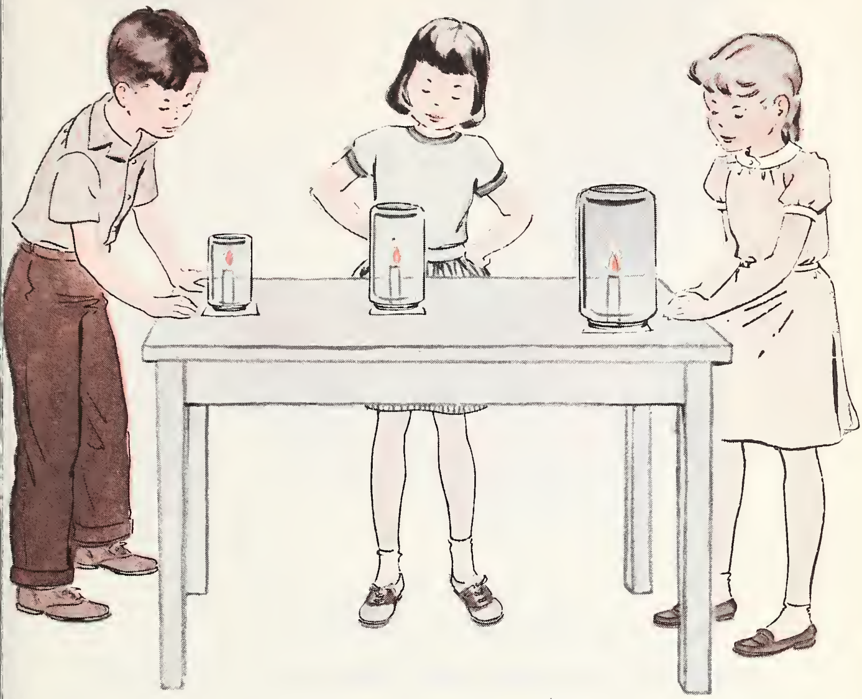
Fire and Air

Some Experiments with Fire

Set a jar over a lighted candle.
What happens?

Try the experiment again.
Try a different candle.
Try a different jar.

What happens each time?

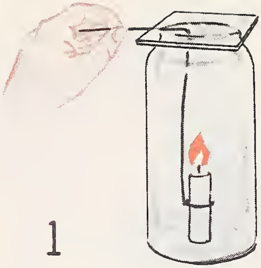


Get three jars of different sizes. Light three candles. Set a jar over each candle.

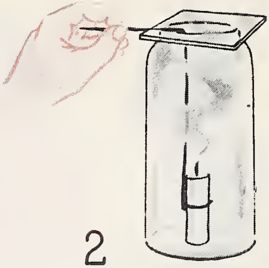
Which candle goes out first?

Which candle goes out last?

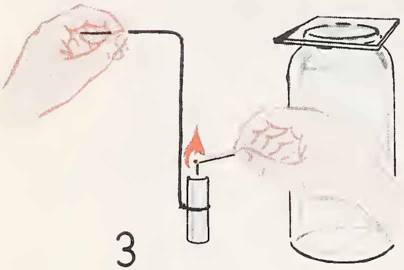
Try the same experiment again. Does the same thing happen again?



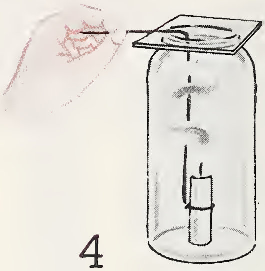
1



2



3



4

Fasten a wire to a candle. Light the candle and lower it into a jar. Cover the jar. What happens?

Light the candle and try it again. What happens?

Blow some fresh air into the jar. Put a lighted candle in the jar again. What happens?

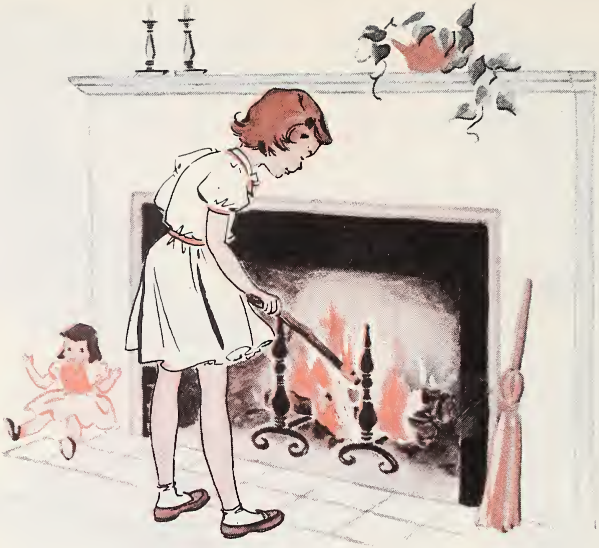
This experiment shows that the candle needs fresh air to burn.

Putting Out Fires

Sometimes people throw soil on fires
to make them stop burning.
Why does soil put out the fires?

The experiments with candles
showed you that candles
must have fresh air to burn. Experiments
with paper and wood will show
that they need fresh air to burn, too.

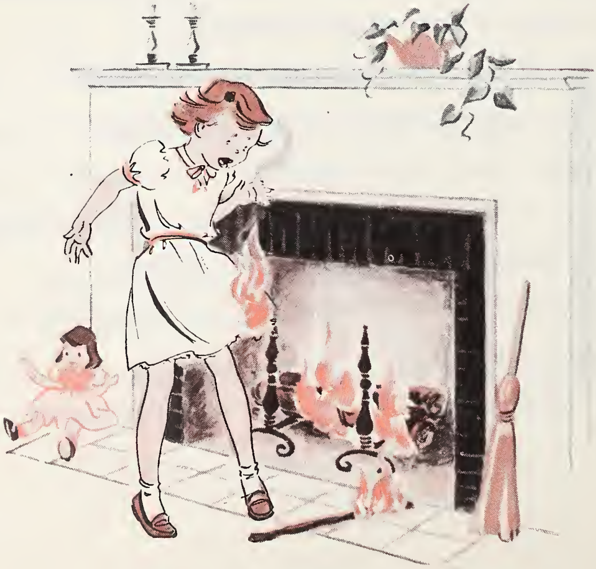
Covering a fire keeps away
the fresh air. Then the fire goes out.



1

This little girl was playing too close to the fire.

Her clothes began to burn.



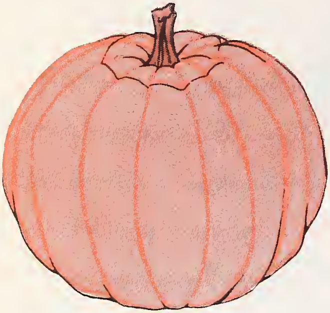
2

Her father wrapped her in a rug.

Why did the rug put out the fire?

What might have happened if the little girl had tried to run?

An Experiment with a Jack-O'-Lantern

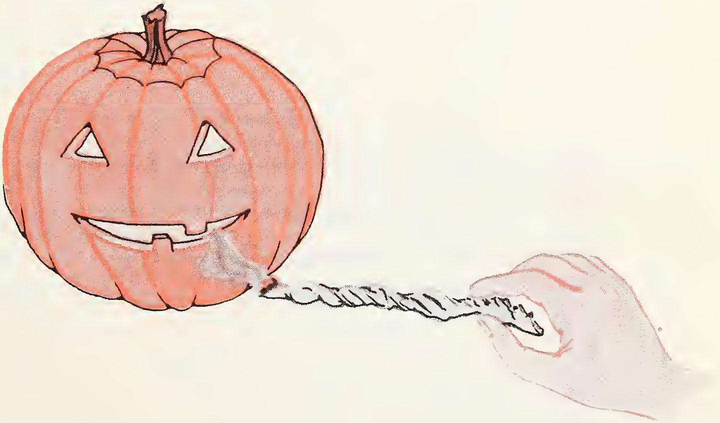


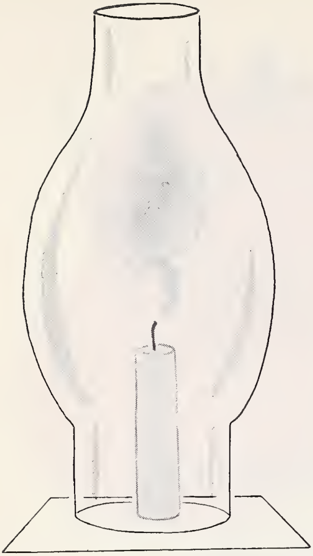
Cut open the top of a pumpkin and dig out the seeds. Put a candle inside and light it. Put on the cover. What happens to the candle?

Now cut holes for the eyes. Light the candle and put on the cover. What happens to the candle?

Cut a mouth in the pumpkin.
Light the candle.
What happens to the candle?

Hold something that smokes
near the holes.
What happens to the smoke?

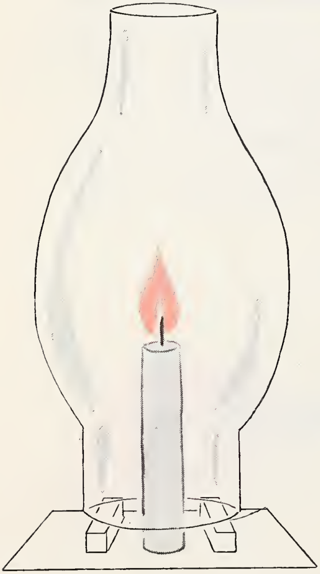




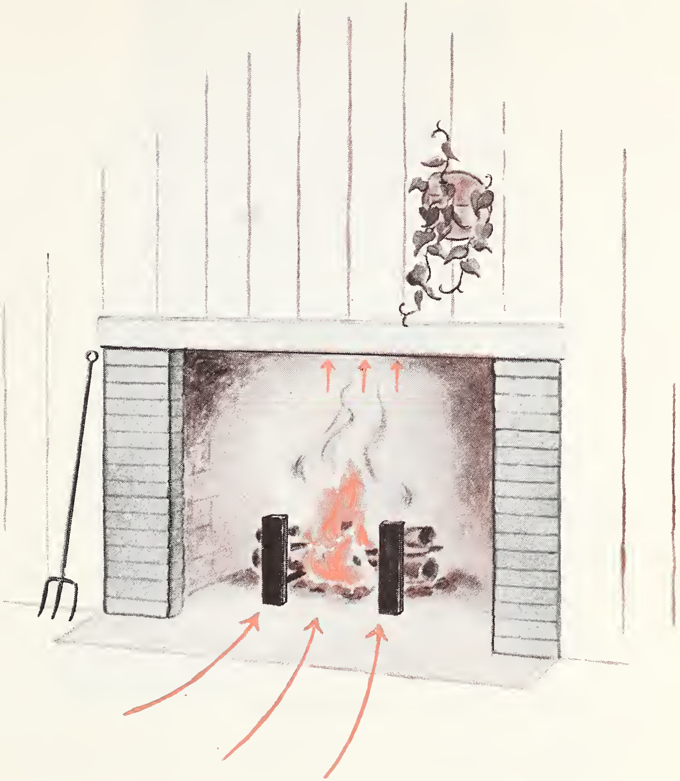
Chimneys

Why does this candle go out?

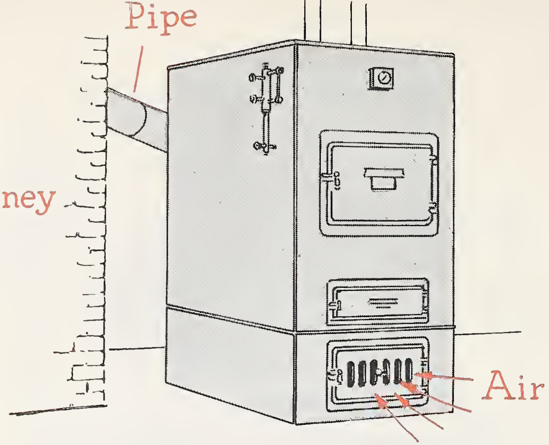
Why does this candle keep burning?



Hold something that smokes near the bottom of the chimney.



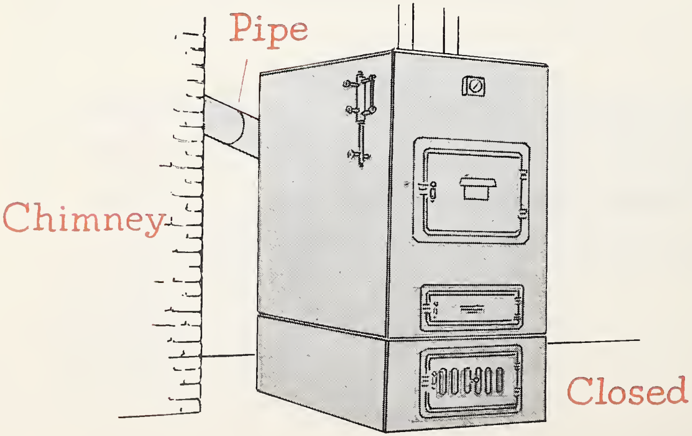
A fireplace works like a lamp chimney. Fresh air goes in the bottom. The fresh air helps the wood burn. Then the air and the smoke go up the chimney.

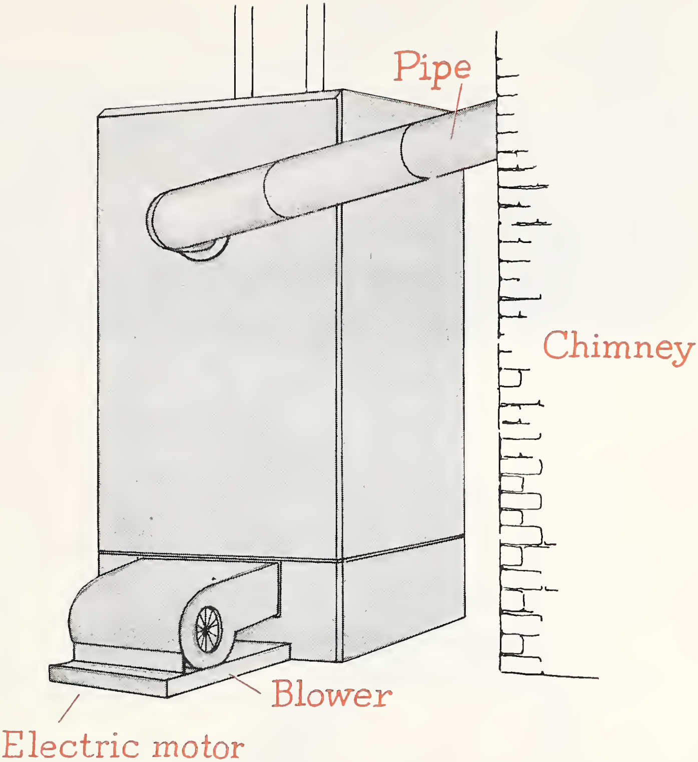


Stoves and Furnaces

Stoves and furnaces must have
fresh air to keep the fires burning.
Holes let the fresh air go in.

You should open the holes
when you want the fire to burn fast.
You should close the holes
when you do not want so hot a fire.





Sometime you may see a furnace that has an electric blower. The blower makes fresh air go into the furnace. The fresh air makes the fire burn faster.

Wind and Fire

Wind makes a fire in the woods burn faster. The fire may kill trees, small plants, and many animals.

What are some things you can do to keep a fire from starting in the woods?

---

1. What must a fire have in order to burn?
2. How can you stop someone's clothes from burning?
3. How does fresh air get in a furnace?
4. Why does wind make a fire burn faster?
5. Why does covering a fire put it out?

Teeth

1

2

Our First Teeth

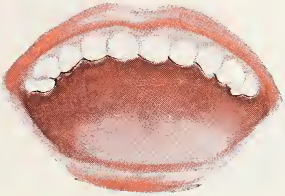
Babies have no teeth
when they are born. Babies get
their first teeth when they are
about six months old. Their other teeth
begin to grow soon afterwards.

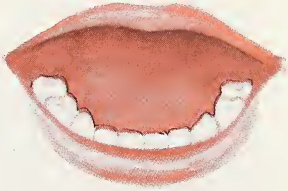
3

4

Children have all the teeth of their first set when they are about two years old.

The pictures below show all the teeth in the first set. How many upper teeth are there? How many lower teeth? How many teeth are there all together?





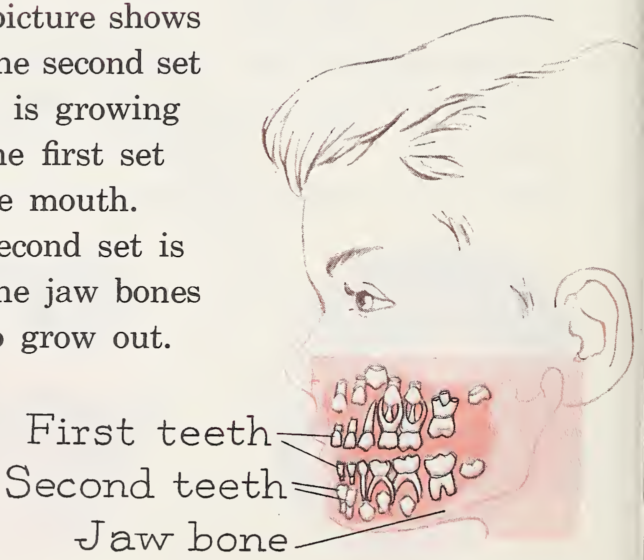
Our Second Set of Teeth

When a child is about six or seven, his first teeth begin to drop out.

New teeth grow in where the first teeth drop out.

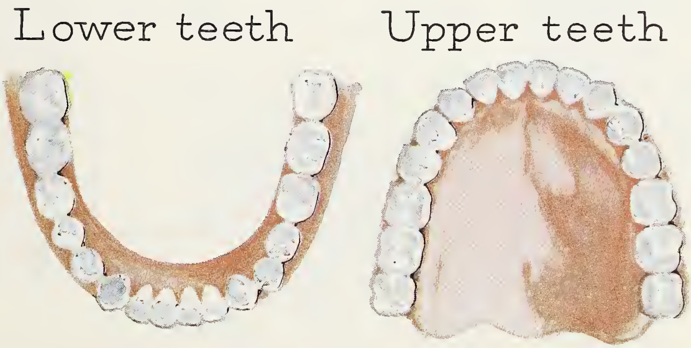
This picture shows where the second set of teeth is growing while the first set is in the mouth.

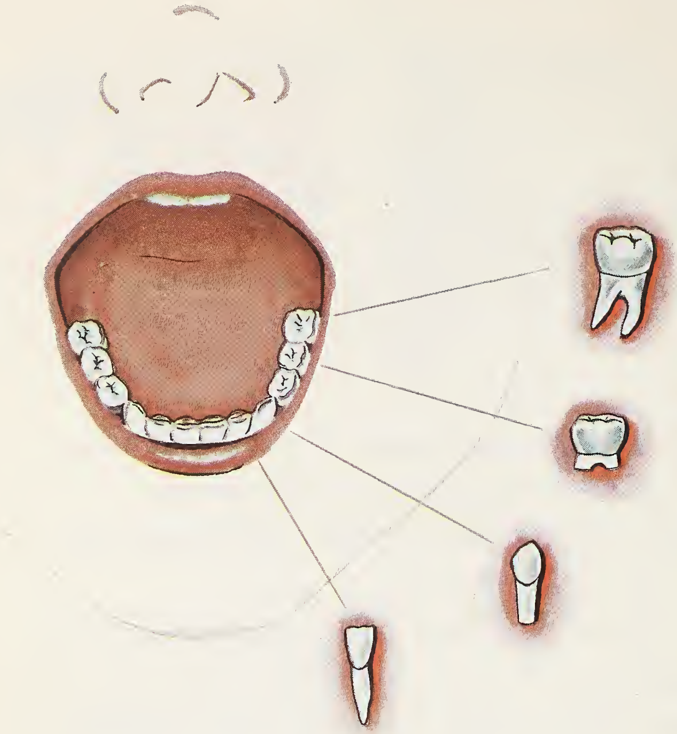
The second set is inside the jaw bones ready to grow out.



All the second teeth have grown out by the time a person is grown up. The pictures below show the second set.

How many teeth are there in the upper jaw? How many teeth are there in the lower jaw? How many teeth are there all together?

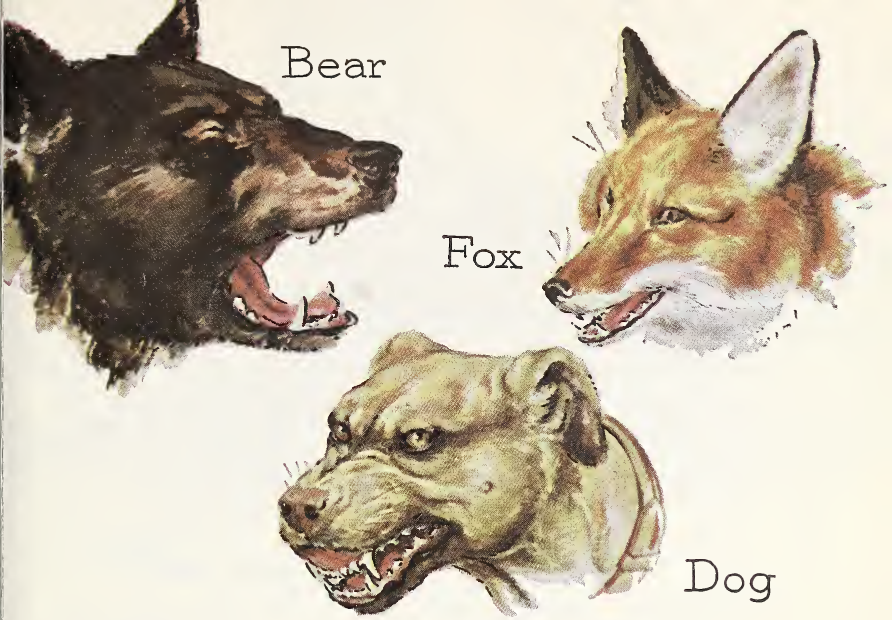




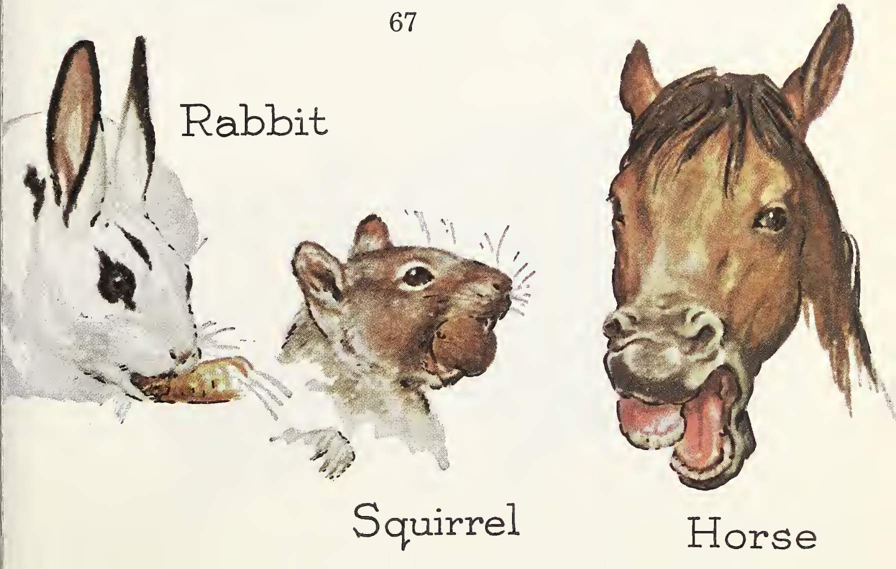
Kinds of Teeth

You have four kinds of teeth.
Feel them with your tongue.
Can you find four kinds?

Look at your teeth in a mirror.
Can you find the four kinds?

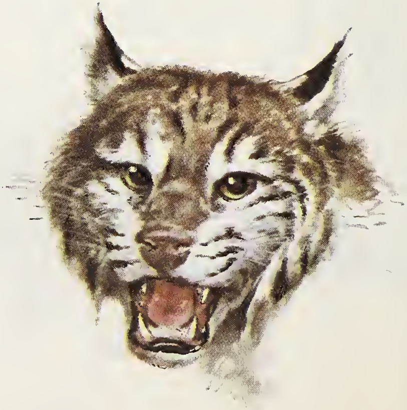


These animals have different kinds of teeth. Look for the different kinds and tell what they are like.



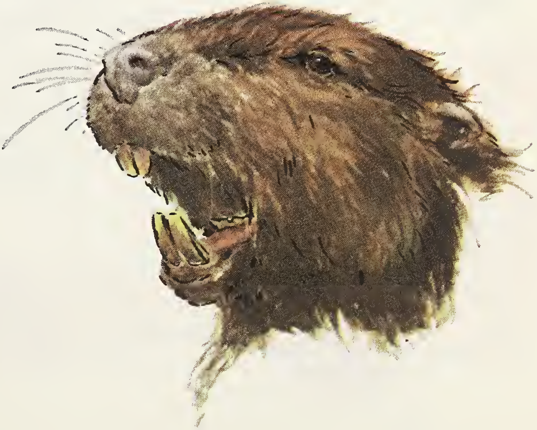
Bobcat

Bobcats have four long pointed teeth.
How may these teeth help them?
Does a cat have teeth like these?
Does a dog?



Beaver

Beavers have four strong front teeth. How do they use these four teeth? What other animals have teeth like these? How do these animals use their teeth?

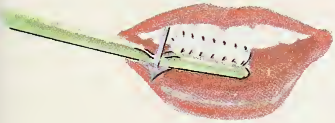


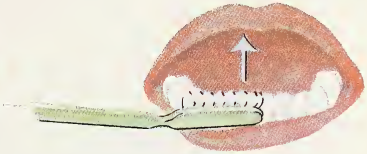
Having Healthy Teeth

You need good foods
to help your teeth grow well.
Doctors tell us that milk
is one of the best foods.
Children should have
about one quart of milk
every day.

Meat and eggs are good foods.
Fresh fruits and vegetables
are good, too. People agree
that cake, pie, candy,
and other sweet foods
are not good for growing teeth.

You should brush your teeth
twice a day.
You should always brush them
before going to bed at night.



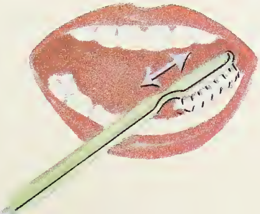


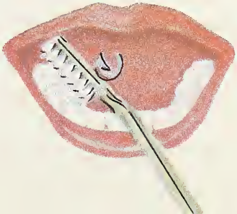
Brush down
on the upper teeth.

Brush up
on the lower teeth.

Brush the tops.

Brush the inside.





A break in the hard part

A hole in the hard part

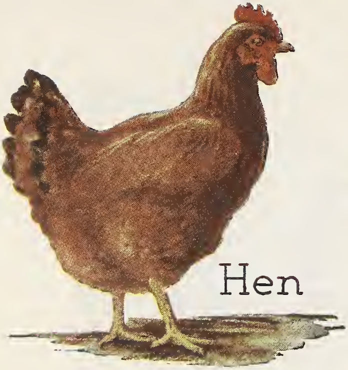
The hole grows bigger

Now the tooth aches

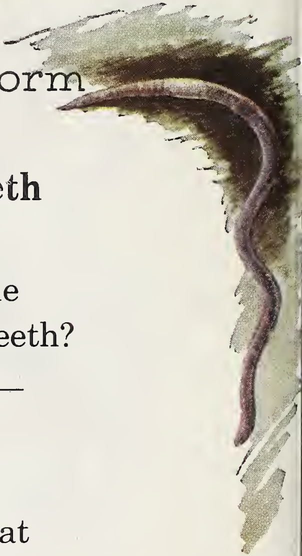
The outside of a tooth is very hard. The inside is soft. If a hole goes through the hard part into the soft part, the hole may grow bigger. Then the tooth may hurt.

A dentist fills small holes in the teeth. Then the holes do not grow larger.

Why should you go to a dentist about twice a year?


Hen

Turtle

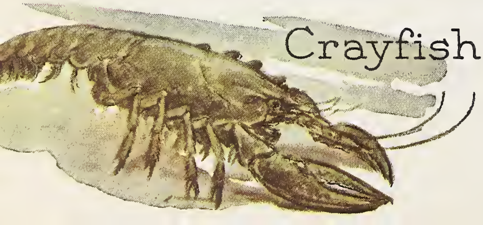

Earthworm

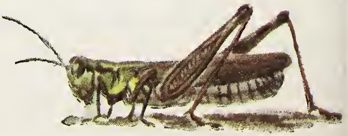
Animals Without Teeth

The animals on this page have no teeth. Can you name other animals that have no teeth?

---

1. How many kinds of teeth do you have?
2. What foods should you eat to help you grow strong teeth?
3. How many teeth should you have by the time you grow up?
4. Why should you go to a dentist often?
5. How many sets of teeth does a person have?


Crayfish


Grasshopper

Animals in Winter

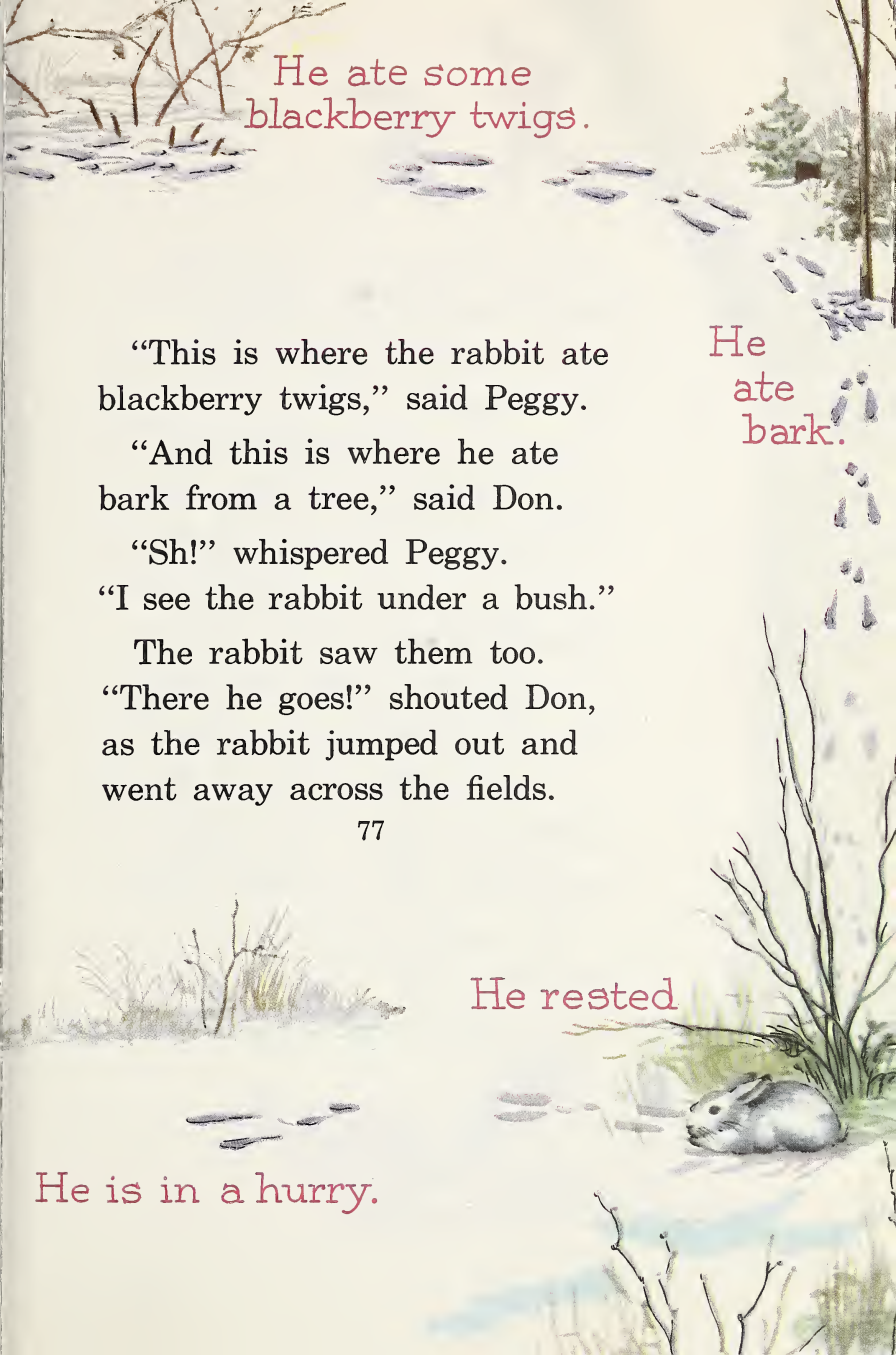
One day Peggy and Don
took a walk in the snow.

"Here are some rabbit tracks,"
called Peggy.
"I wonder which way they go."

"They go this way," said Don.
"A rabbit puts his hind feet
ahead of his front feet
when he hops."

"Look! This is where
the rabbit sat up," said Don.
"You can see his tail mark."

He puts his hind feet
ahead of his front feet.

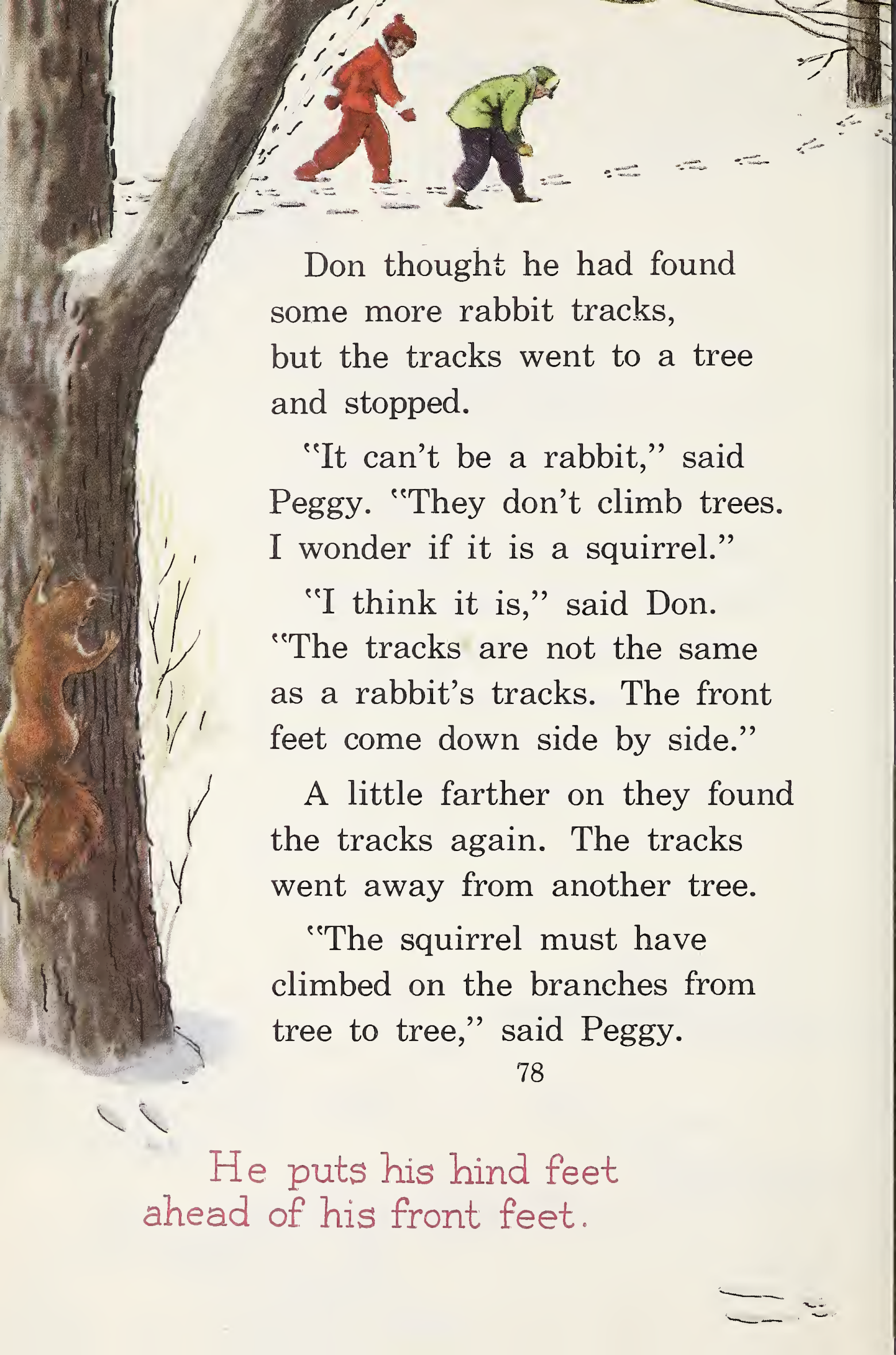

He ate some blackberry twigs.
He ate bark.
He rested
He is in a hurry.

"This is where the rabbit ate blackberry twigs," said Peggy.

"And this is where he ate bark from a tree," said Don.

"Sh!" whispered Peggy.
"I see the rabbit under a bush."

The rabbit saw them too.
"There he goes!" shouted Don, as the rabbit jumped out and went away across the fields.



He puts his hind feet
ahead of his front feet.

Don thought he had found
some more rabbit tracks,
but the tracks went to a tree
and stopped.

"It can't be a rabbit," said
Peggy. "They don't climb trees.
I wonder if it is a squirrel."

"I think it is," said Don.
"The tracks are not the same
as a rabbit's tracks. The front
feet come down side by side."

A little farther on they found
the tracks again. The tracks
went away from another tree.

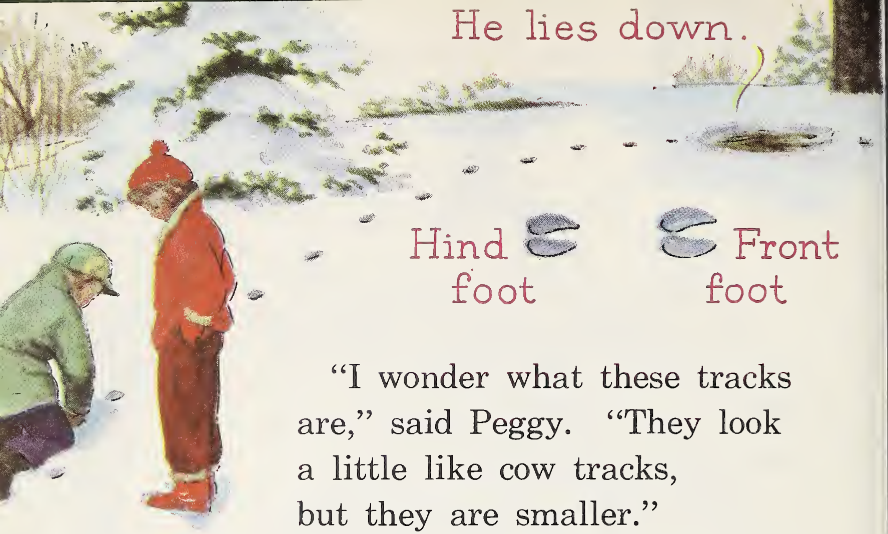
"The squirrel must have
climbed on the branches from
tree to tree," said Peggy.

The tracks went on. They led to a hole in the snow. Bits of a nutshell lay beside the hole.

"How did the squirrel know where to dig for the nut?" asked Peggy.

"I don't know," said Don. "Maybe he could smell it, or maybe he remembered where he put it last fall."

"There is the squirrel now," called Peggy, as the squirrel ran over the snow and climbed a tree trunk.

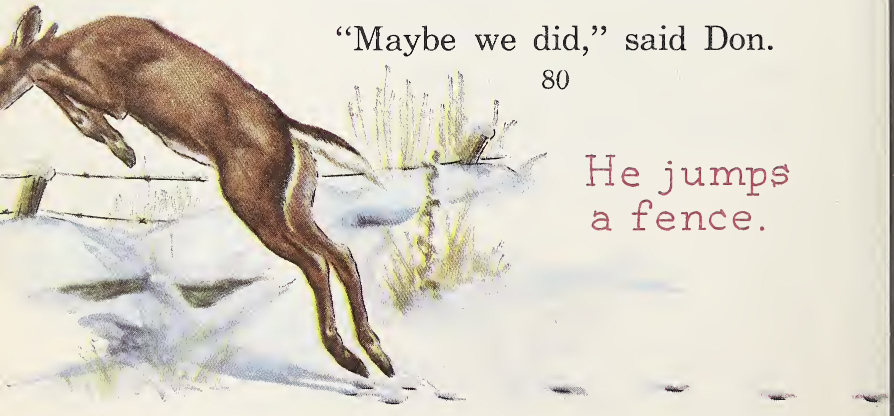


"I wonder what these tracks are," said Peggy. "They look a little like cow tracks, but they are smaller."

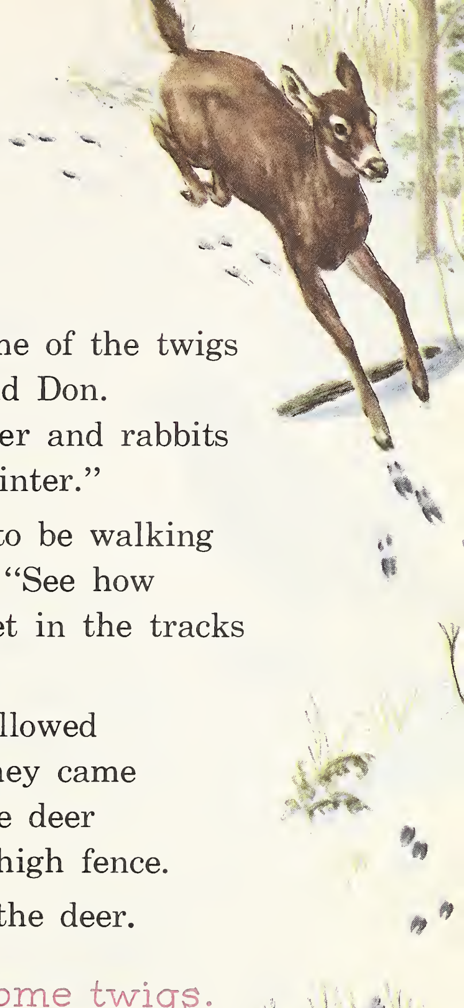
"I know what they must be," said Don. "They are deer tracks."

"The deer must have been lying down here," said Peggy. "Then something scared him. I wonder what scared him."

"Maybe we did," said Don.


He jumps a fence.

He is in a hurry.



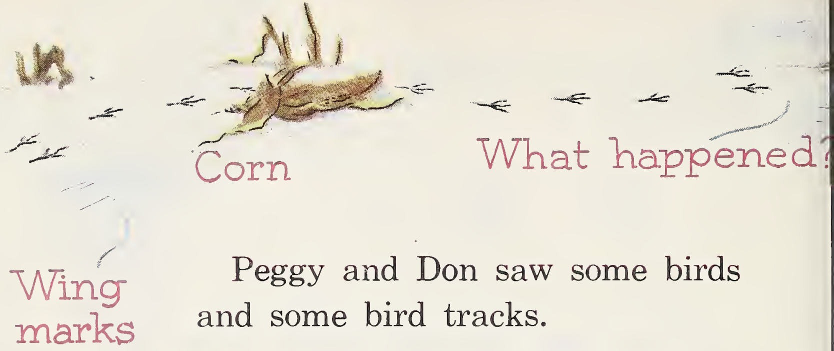
"The deer ate some of the twigs from this bush," said Don. "It must be that deer and rabbits both eat twigs in winter."

"The deer seems to be walking here," said Peggy. "See how he puts his hind feet in the tracks of his front feet."

Peggy and Don followed the deer tracks. They came to a place where the deer had jumped over a high fence.

They did not see the deer.

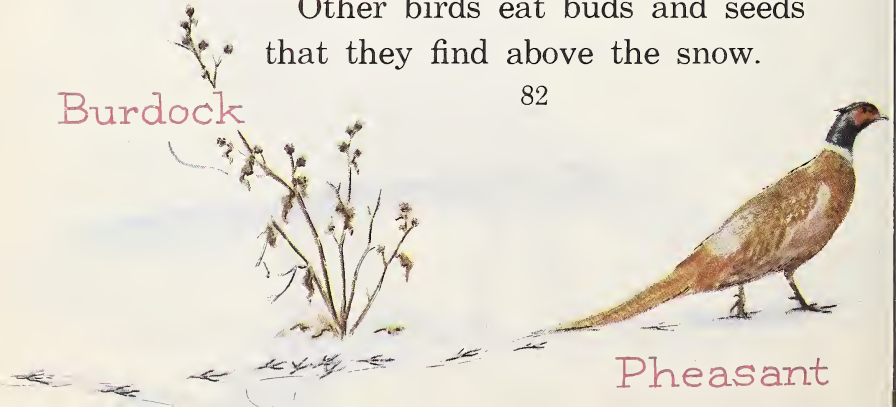
He eats some twigs.



Peggy and Don saw some birds and some bird tracks.

They saw crows. Crows eat many things in winter. They eat buds, seeds, dead animals, and almost any kind of food that they can find.

Other birds eat buds and seeds that they find above the snow.



Then Peggy and Don saw a woodpecker. It used its bill to dig into a tree for insects.

They saw a nuthatch walking down a tree trunk.

It was looking for insects in cracks in the bark of the tree.

They saw some sparrows eating seeds. Sometimes the sparrows dropped the seeds. Then they flew down and picked up the seeds from the snow.

What happened?

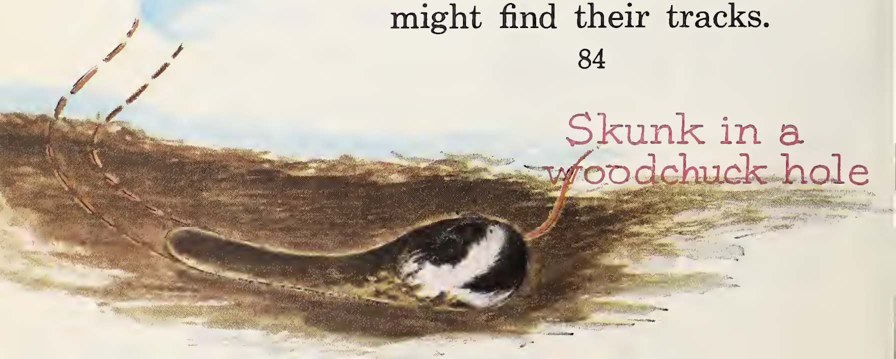
Raccoon in a hollow tree

There were many animals that Peggy and Don could not see. Some animals crawl into holes and become quiet in cold weather.

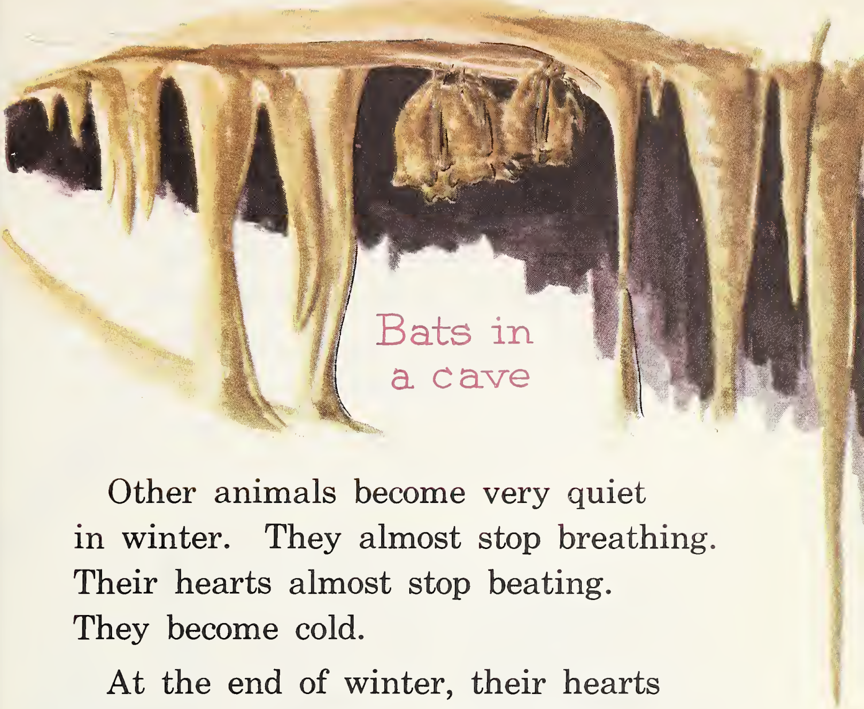
A raccoon was sleeping in a hollow tree. But Peggy and Don could not see it.

A skunk was asleep underground in an old woodchuck hole. But Peggy and Don could not see it.

On warm winter days, some of these animals come out for a while. Then Peggy and Don might find their tracks.



Skunk in a woodchuck hole

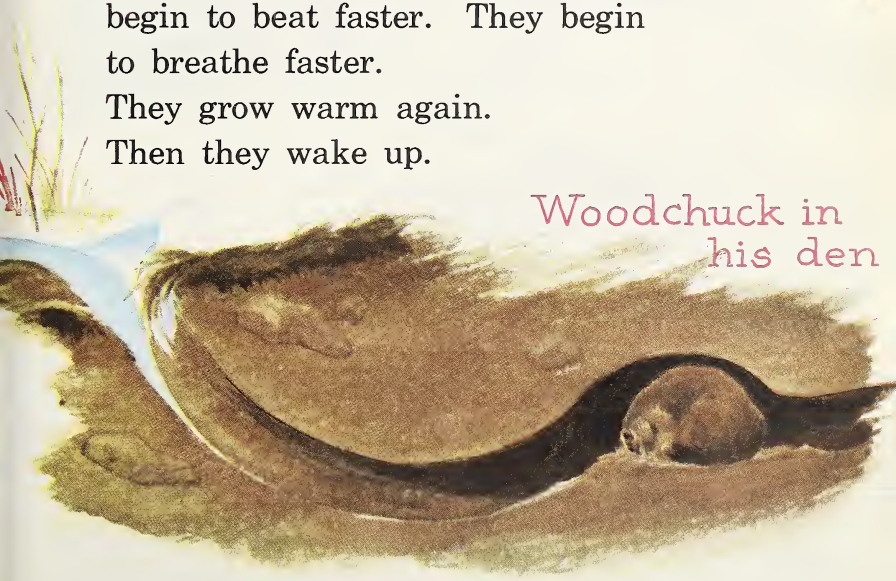


Bats in a cave

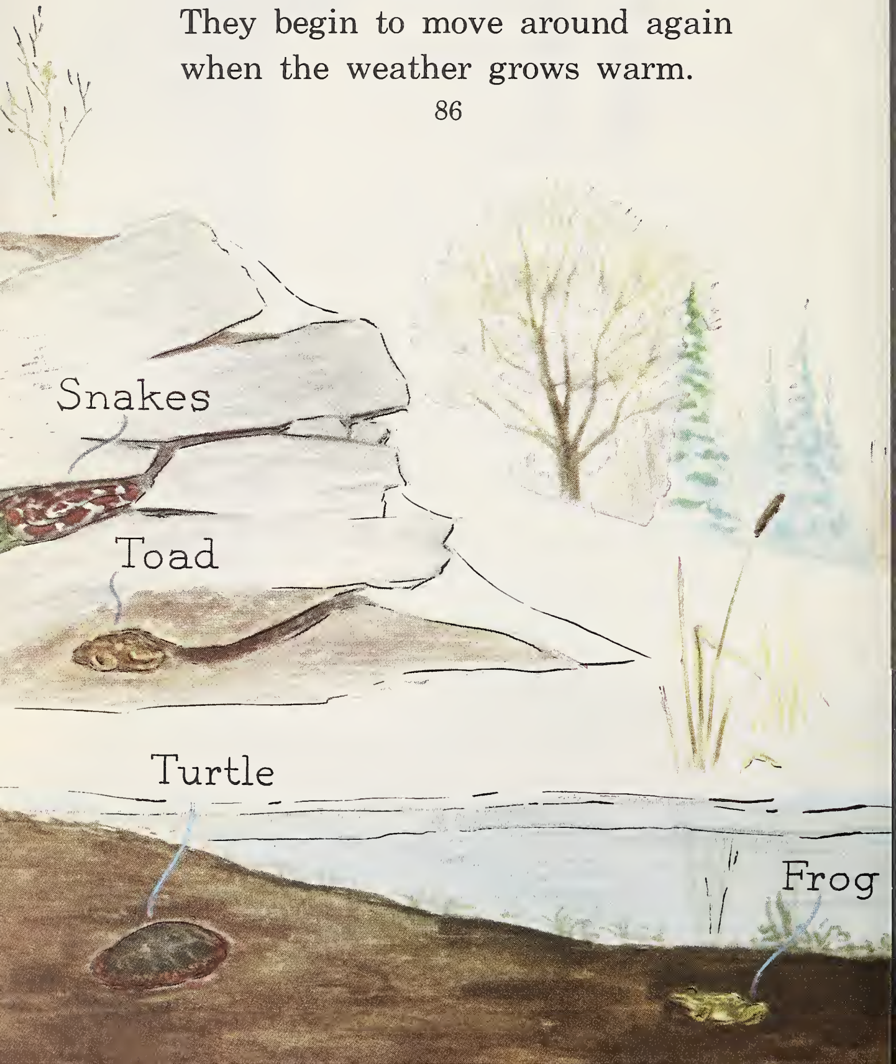
Other animals become very quiet in winter. They almost stop breathing. Their hearts almost stop beating. They become cold.

At the end of winter, their hearts begin to beat faster. They begin to breathe faster. They grow warm again. Then they wake up.

Woodchuck in his den



Toads, frogs, snakes, and turtles become quiet in cold weather. They almost stop breathing. Their hearts almost stop beating. They begin to move around again when the weather grows warm.



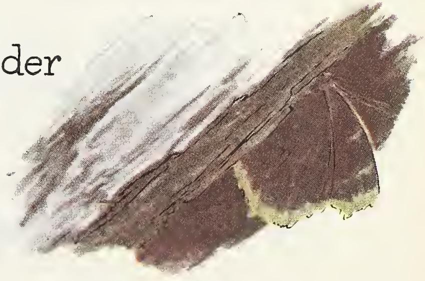
Many insects die in autumn.
Their eggs hatch when spring comes.

Cocoon

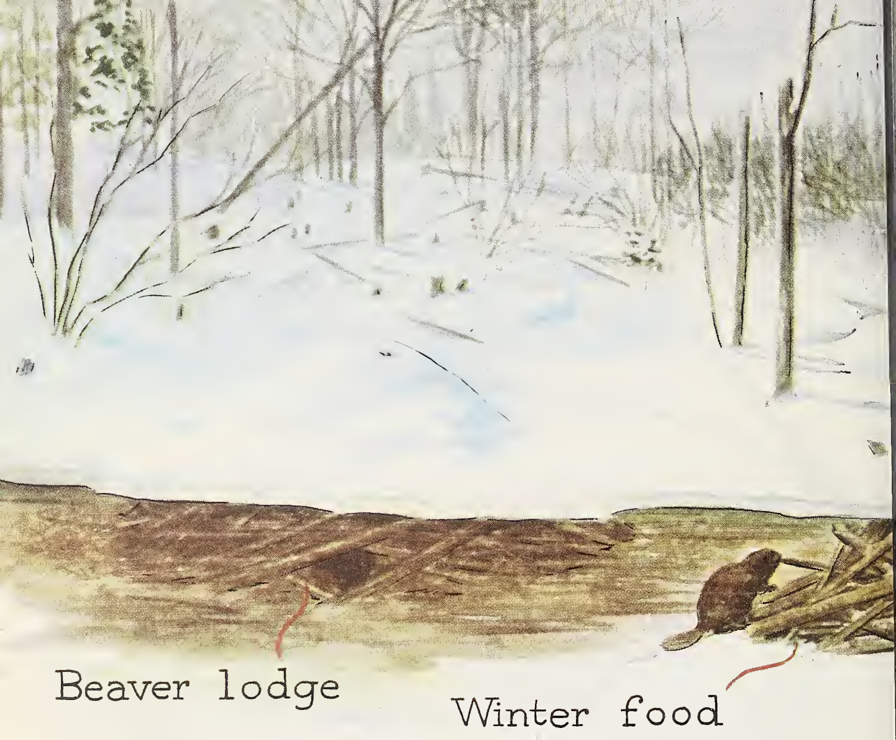
Eggs

Some insects do not die in autumn.
They spend the winter in places away from the winds, rain, and snow.
They are quiet while they are cold.
They begin to move around when the weather is warm again.

Caterpillar under stones



Butterfly in a hollow tree



In autumn beavers cut down trees.
They cut the trees into short pieces.
They drag the pieces to the water
and fasten them down with mud.

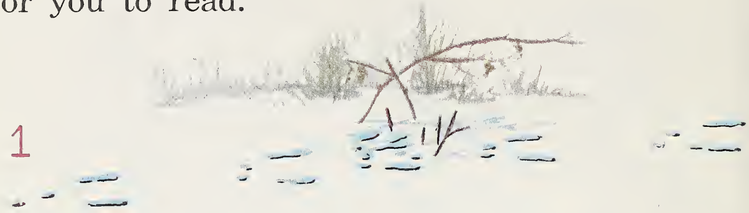
When the pond is covered with ice,
the beavers eat the bark
from the pieces of wood.

Before Peggy and Don went home they walked near some bee hives. No bees were flying around.

The bees had made honey from flowers all summer long. They put the honey in their hives. Now they had food to eat for the winter.

Here are some track stories for you to read.

1



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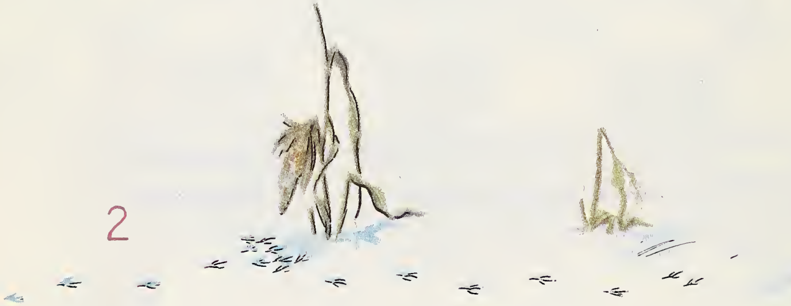

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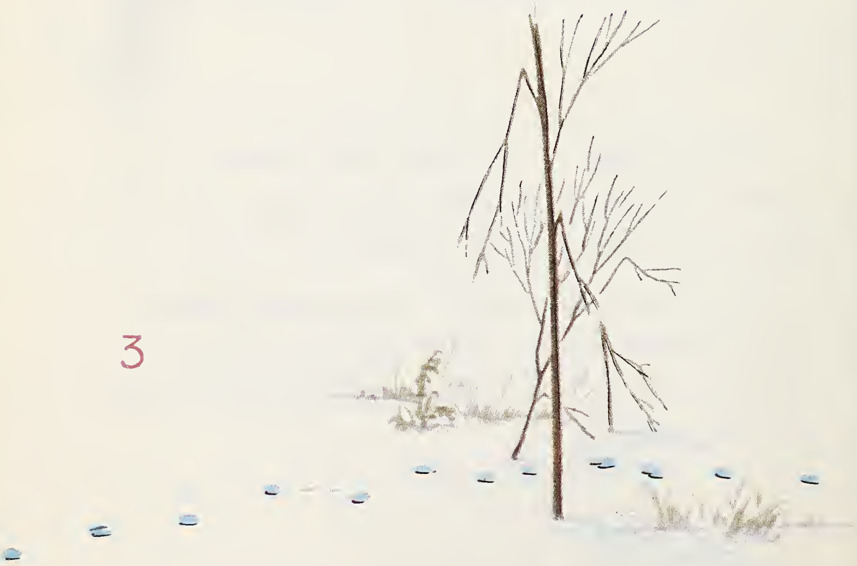

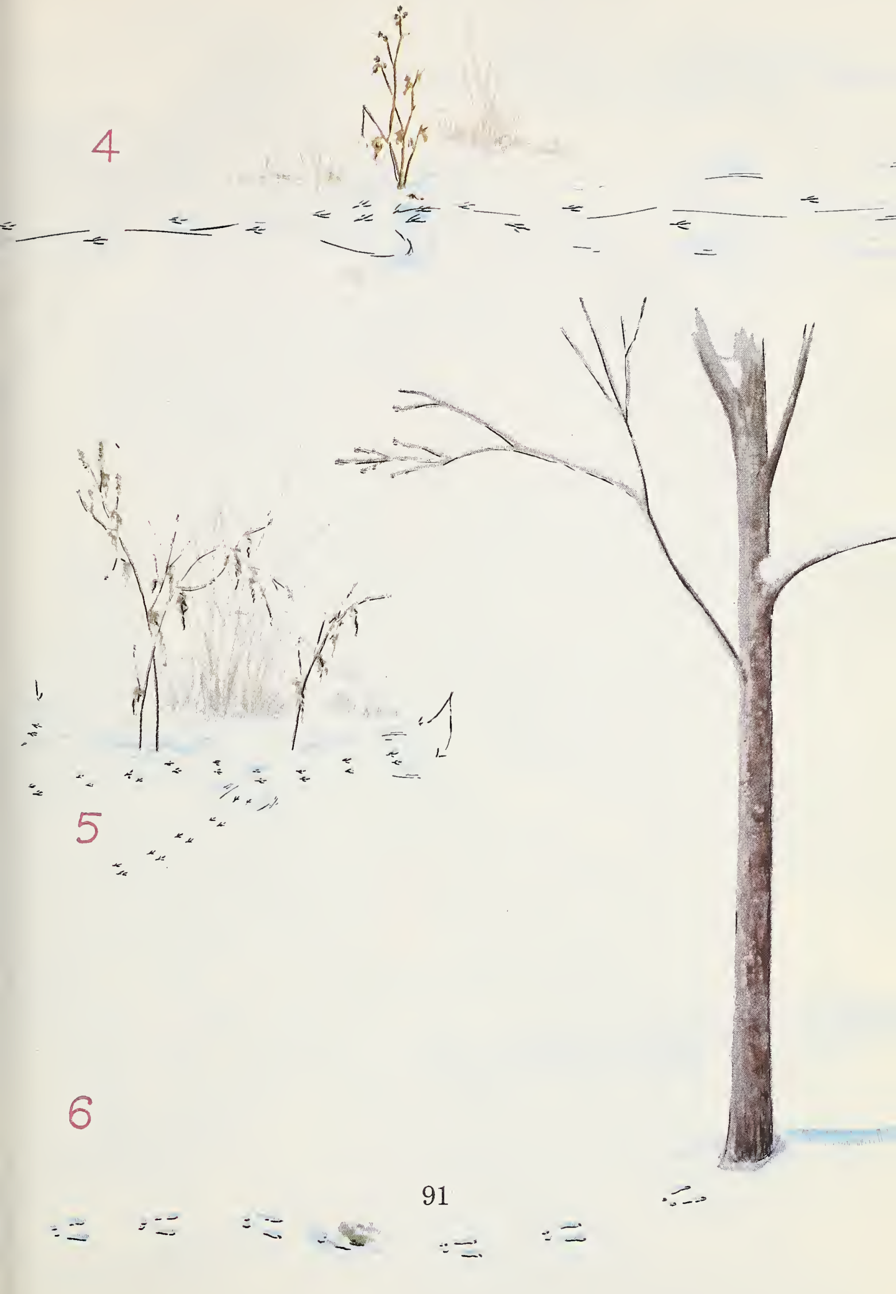
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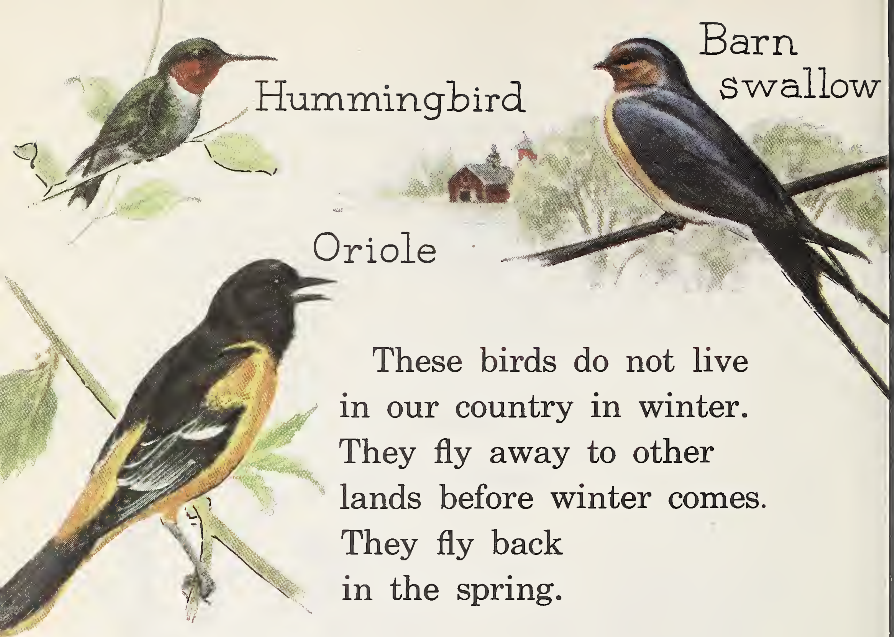
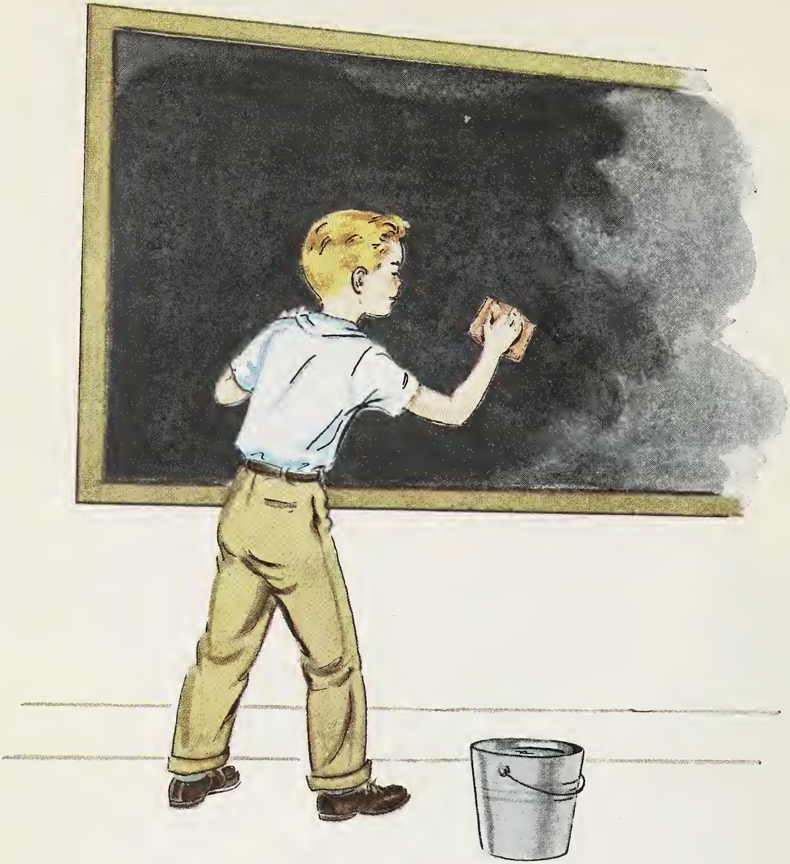


These birds do not live in our country in winter. They fly away to other lands before winter comes. They fly back in the spring.

---

1. What is one difference between cat and dog tracks?
2. How can you tell a rabbit track from a squirrel track?
3. What do rabbits eat in winter?
4. Name a bird that stays with us in winter.
5. How does a woodchuck spend the winter?
6. How do insects spend the winter?
7. What foods do some birds find in winter?

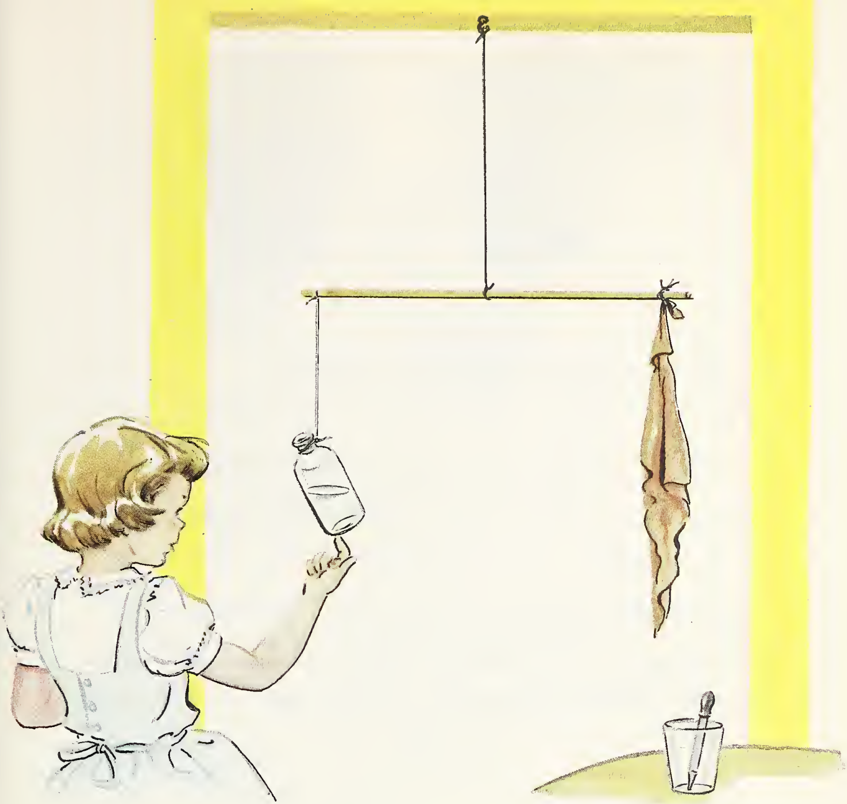
Water in the Air



Water Goes into the Air

Wash the blackboard.
Watch it dry.
The water goes into the air.

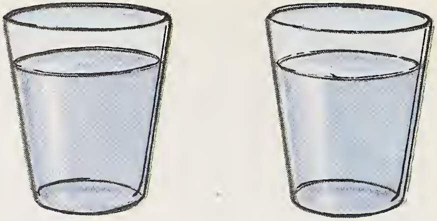
When water goes into the air it **evaporates.**



Tie a damp cloth to one end of a stick. Tie a bottle to the other end. Put water in the bottle until the stick is level.

Watch the stick for a few minutes. It does not stay level. Which end becomes lighter? Can you tell why?

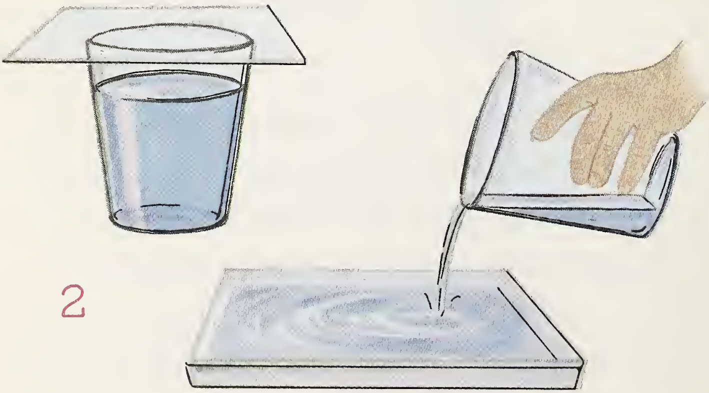
1



Pour water into two glasses. Put the same amount in each glass.

Put a cover on one of the glasses. Pour the water from the other glass into a pan.

Put the glass of water and the pan of water where they will not be spilled. Leave them until the next day.



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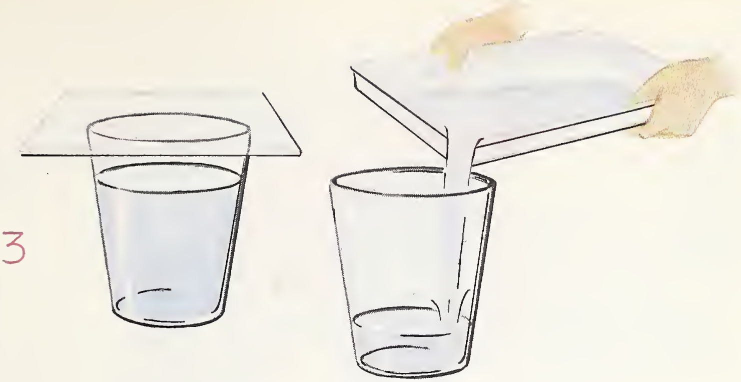
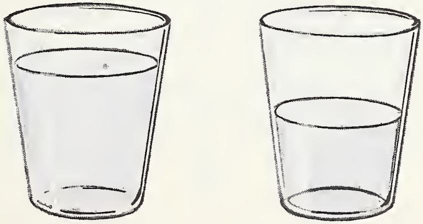


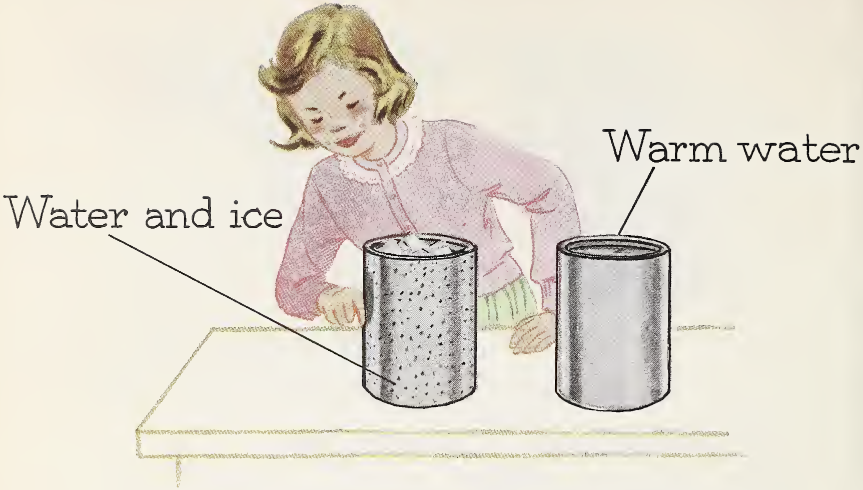
Pour the water from the pan
back into the glass.
Stand the two glasses side by side.

Is there still the same amount of water
in each glass? Which glass
has less water in it? Can you tell why?

Water goes into the air
when it evaporates.
It changes into **water vapour.**
You cannot see water vapour,
but it is in the air all around you.

4





Water Comes from the Air

Fill a can with water and ice.
Fill another can with warm water.
Let them both stand a few minutes.

Now look at the cans.
Touch the outside of each one.
There is water on the outside
of one can. Which one?
Did it go through the can?

The water must have come
from the air near the can.
Water that comes on cold things
from the air is called **dew.**

Cut a hole in the bottom of a cardboard box.

Hold the box against a cold window and blow into the hole. Take away the box. Look at the window.

There is dew on the cold glass. Where did it come from?

Water vapour in your breath changed into drops of water. When water vapour changes into drops of water it **condenses.**

Hot water

Cold water

Water Evaporates and Condenses

Put hot water in a glass.
Put a cool, dry glass upside down
over it. What happens?

Water in the lower glass evaporates.
The water vapour rises
into the upper glass
Can you see the water vapour?

The water vapour is cooled
by the cool glass. The water vapour
condenses into drops of water.

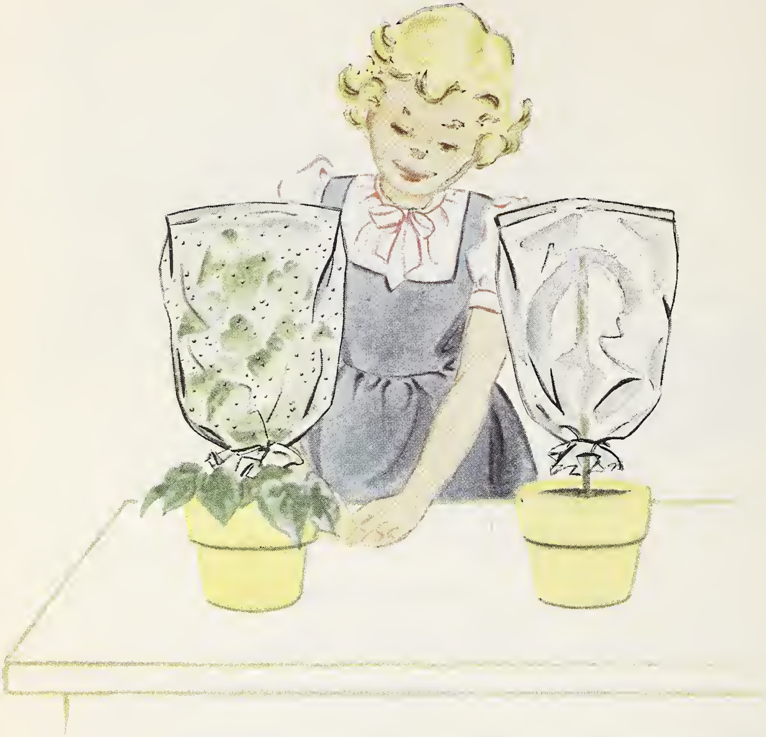
Try the same thing with cold water.
What happens?

Does hot water or cold water
evaporate more quickly?

Heat makes water evaporate
more quickly. The boiling water
in the teakettle is evaporating rapidly.
Water vapour comes from the teakettle,
but you cannot see it.

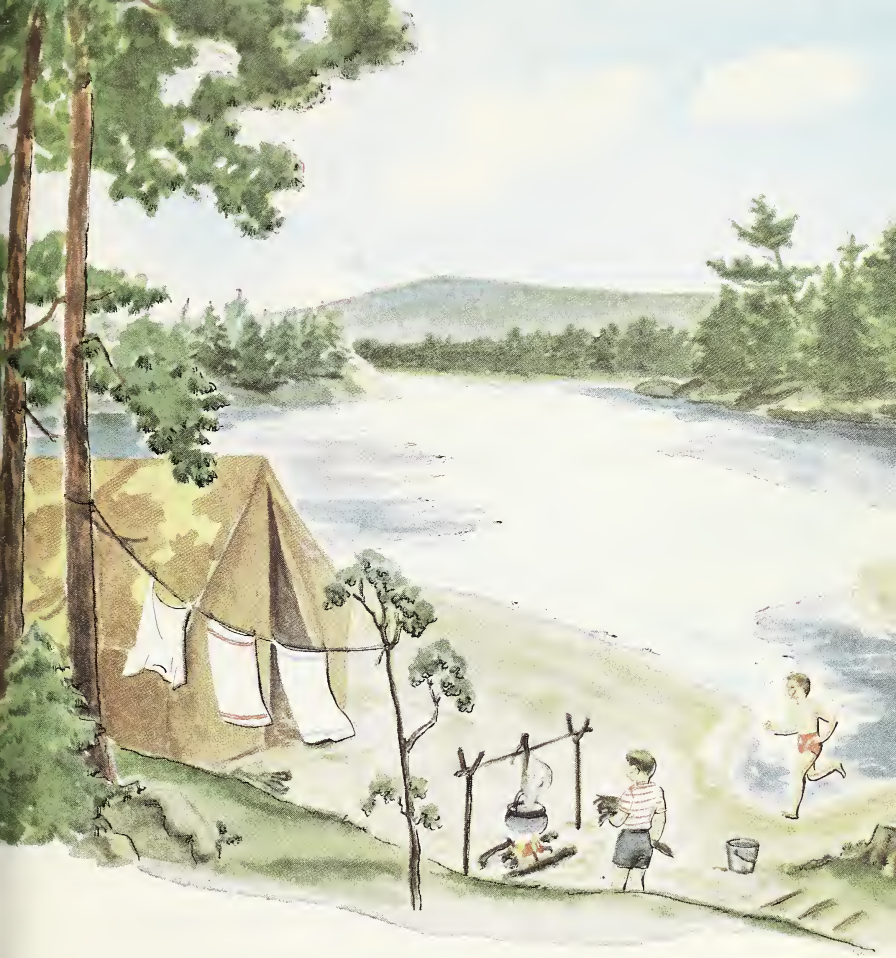
The water vapour cools
in the air above the teakettle.
It condenses into tiny drops of water.
You can see the clouds
of tiny drops of water.

The cloud above the teakettle
is like a cloud in the sky.



Tie a cellophane bag over some leaves of a plant. Tie another cellophane bag on a stick.

Look at the bags the next day.
In which bag did water collect?
How do you know the water
came from the leaves?



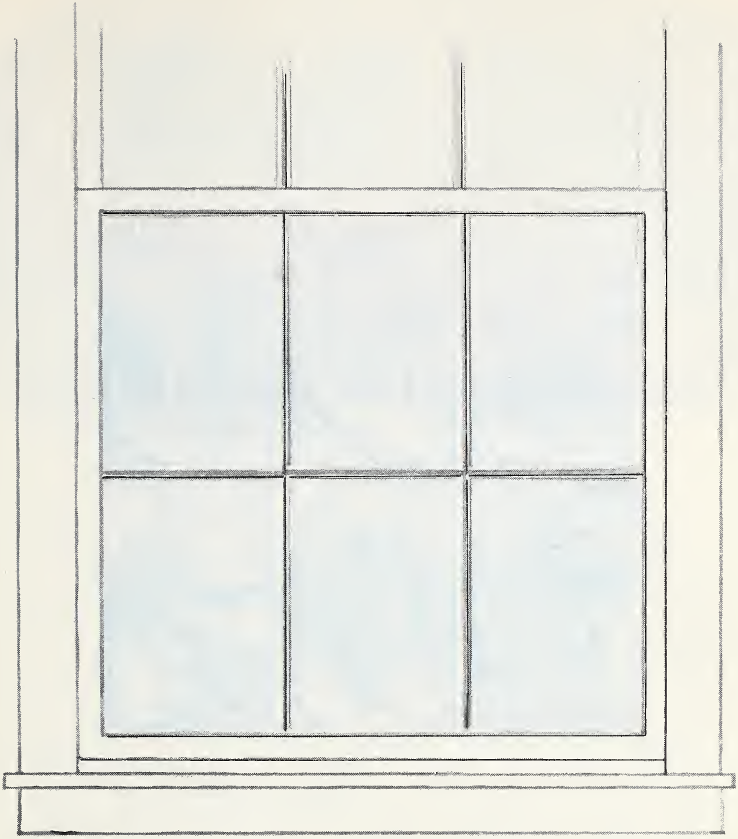
Name the places in the picture where water is evaporating.

Is water condensing anywhere in the picture?

Dew and Frost

Sometimes there is dew on plants
in the morning. The dew came
from the air near the plants.
Have you ever seen dew
on anything else in the morning?
On what?

On clear nights, things near the ground
often become cooler than the air.
Then the water vapour in the air
condenses and becomes dew.
When the temperature is below freezing,
the water vapour becomes **frost.**



Frost may collect on the insides of windows in winter.

Where did the frost come from?

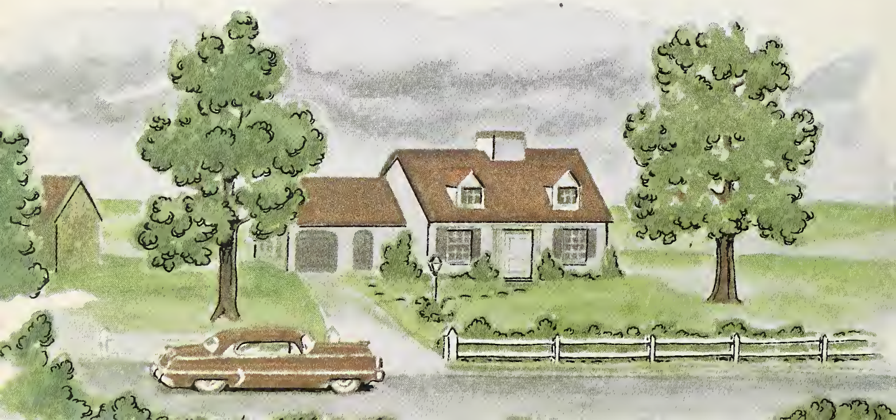
Why is it frost and not dew?

Where do you think the water vapour in the room came from?

Above and Below the Clouds

The picture at the top of the page shows what it is like above the clouds. The sun is bright. The sky is blue. An airplane would make a shadow on the clouds below it.

The picture below shows a cloudy day. The sky is gray. You cannot see the sun. There are no shadows.

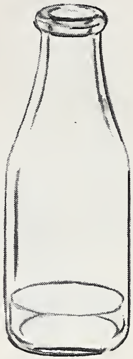


The picture at the top of the page shows what it is like above the clouds. The sky is clear. The moon and stars are shining.

The picture below shows a cloudy night. The sky is dark. You cannot see the moon and the stars. The only lights are man-made lights.

Making a Cloud in a Bottle

1


2

Fill a bottle
with hot water
for a few minutes.

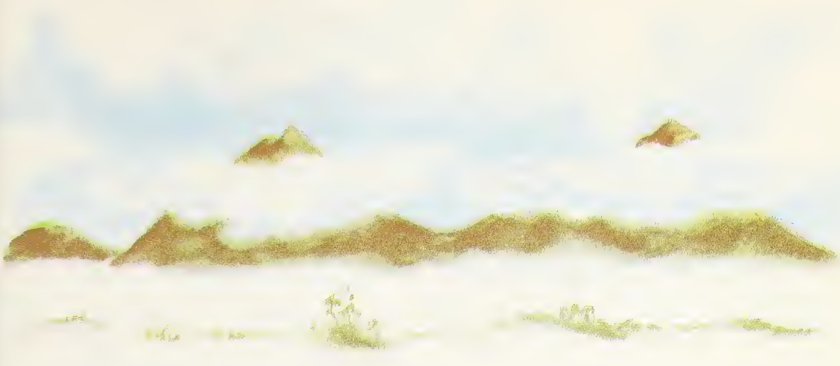
Then pour out
most of the water.

Hold a burning
straw in the bottle.

Put a piece of
ice on the bottle.

3

4



How Clouds Are Formed

The cloud in the bottle was made
of tiny drops of water. The ice
cooled the water vapour in the air.
The water vapour condensed
on bits of smoke from the burning straw.

Clouds in the sky are made
when water vapour condenses
on dust and smoke in the air.

Sometimes the clouds
are high in the air.
Sometimes the clouds
are near the ground.
Clouds near the ground
are called **fog**.

Clouds and Airplanes

When there are clouds in the sky, airplanes usually fly above them or below them.

Being in a cloud is like being in fog. You cannot see very well.

What might happen if two airplanes were both flying inside a cloud?

Some days there is a thick fog
over the ground. It is not safe to fly
at all. The airplanes stay on the ground.

The air usually becomes clear again
in a few hours. The water may fall
as rain. Sometimes the wind
blows the clouds away.
The sun may heat the air
and evaporate the drops of water.
If one of these things happens,
it is safe to fly again.

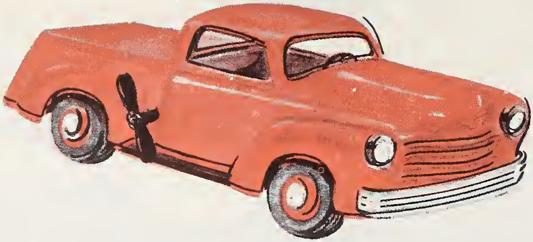
Where does the snow come from? Why does snow fall instead of rain?

What will happen to the snow in the spring? Where will the snow go?

---

1. Name some places where water evaporates.
2. Name some places where water condenses.
3. How is dew formed? How is frost formed?
4. What are clouds? How are they formed?
5. What is fog?
6. How can you make water evaporate faster?
7. Why are pilots interested in clouds?

Making Things Move



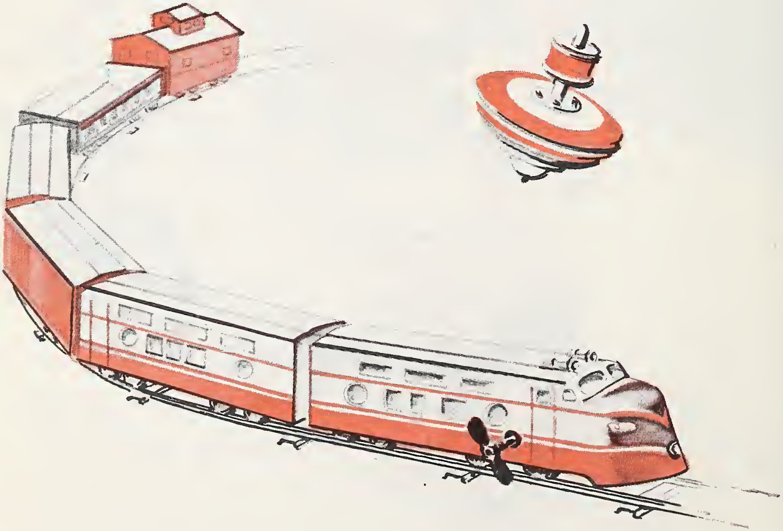
Energy and Toys

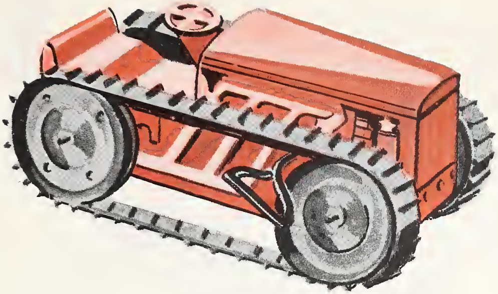
Some toys will move if we wind them.

When we wind a toy we give it **energy.**

The energy makes the toy move.

Energy can make things move.

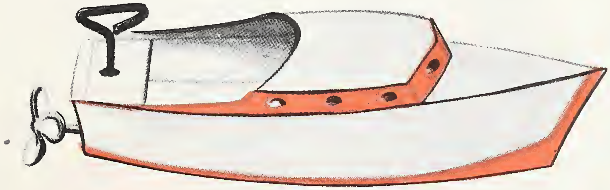


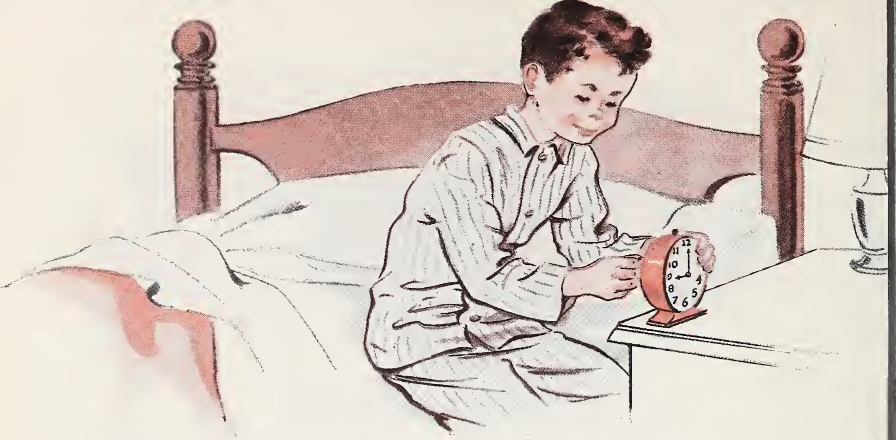


On these pages are some toys
that wind up. When you wind them up
you give them energy.

What does the energy
make each toy do?

Bring in different kinds
of wind-up toys.
Show how you give them energy.
Show what the energy makes each toy do.

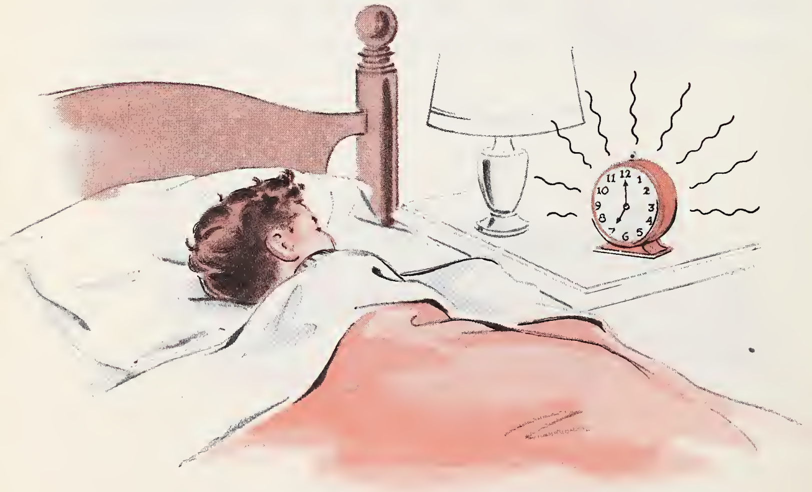


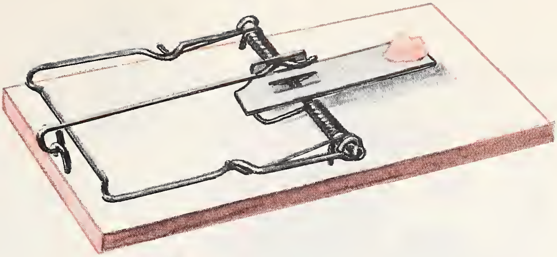


Storing and Using Energy

What is the boy doing? Why is he doing it? At what time does he give the clock energy?

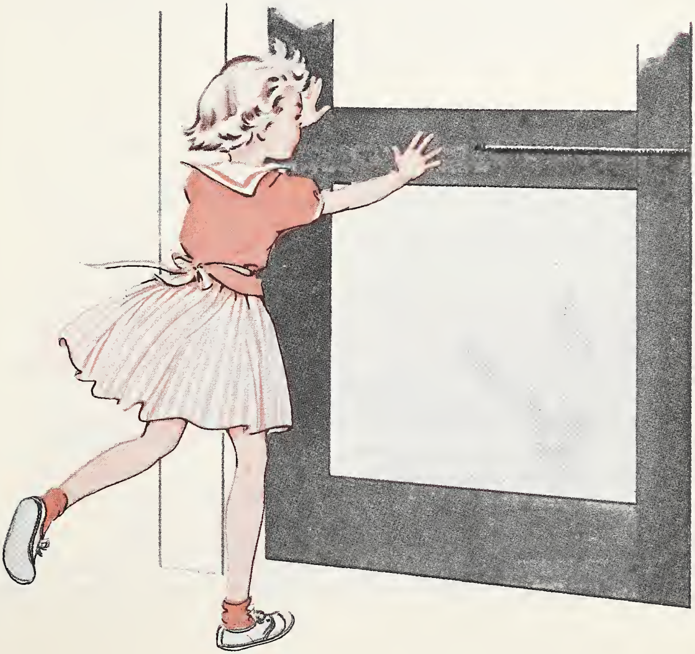
At what time does the energy make the clock ring?

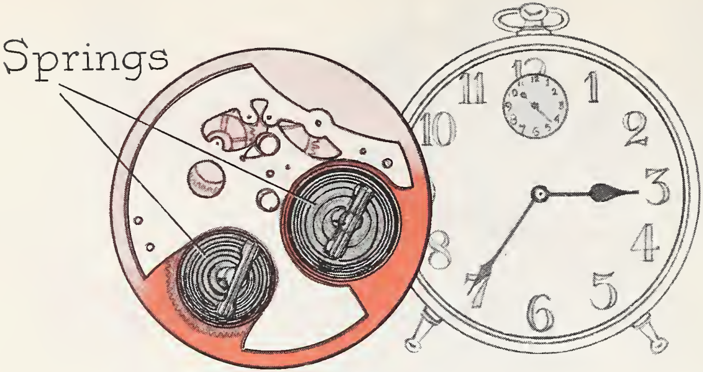




Energy can be stored in the spring of this mouse trap.
When will this energy be used?

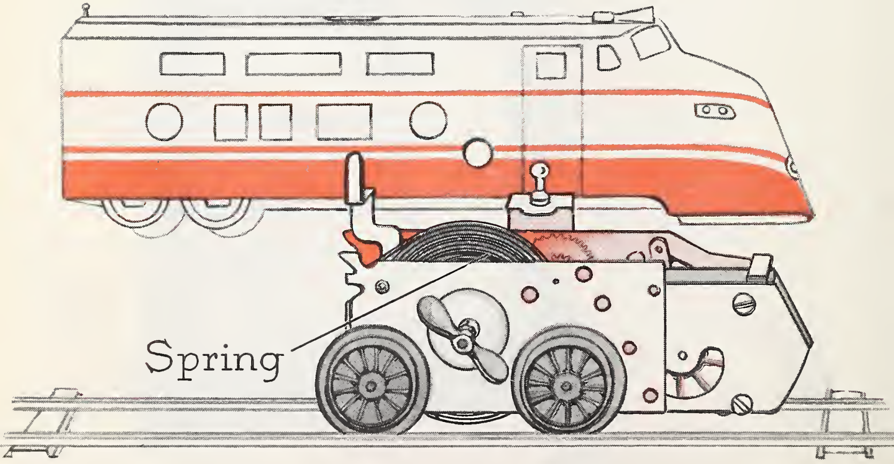
Energy can be stored in the spring of this screen door.
When will the energy be used?
What will this energy do?

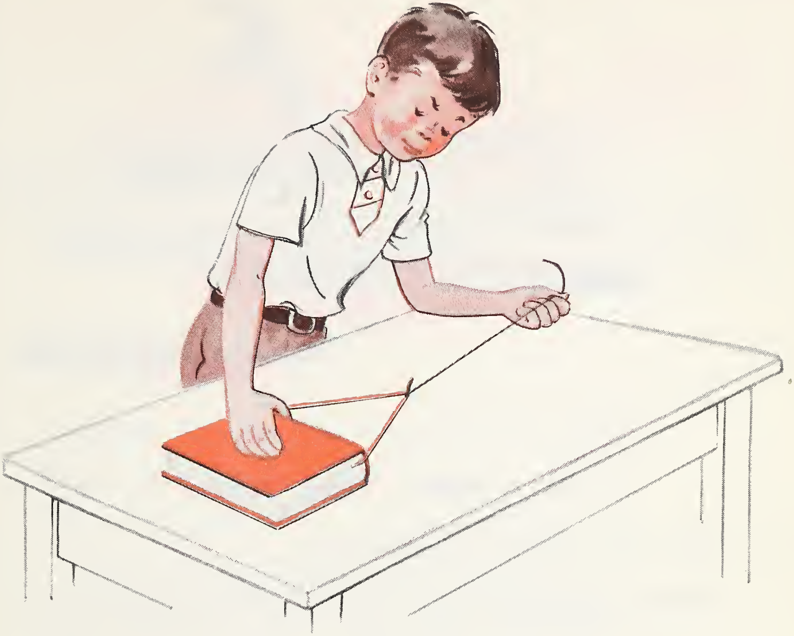




You store energy in the springs of a clock when you wind them. Look for the springs in an old clock.

You store energy in the spring of a toy that you wind up. Look for the spring in a toy that you wind up.



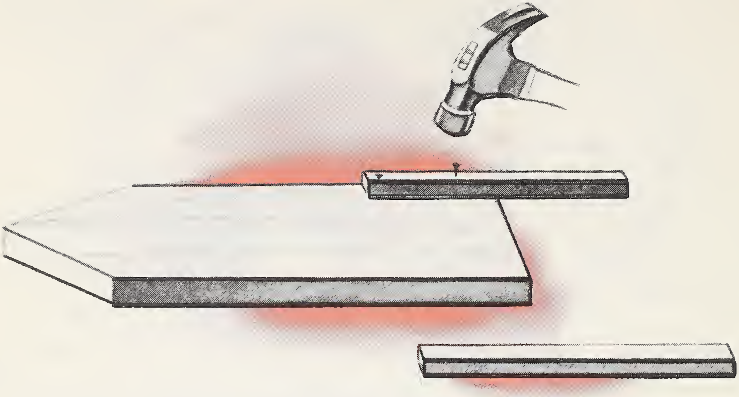


Fasten a rubber band to a book
with a string.

Hold the book down with one hand.
Pull on the rubber band
with the other hand.

Now lift your hand from the book.
What happens?

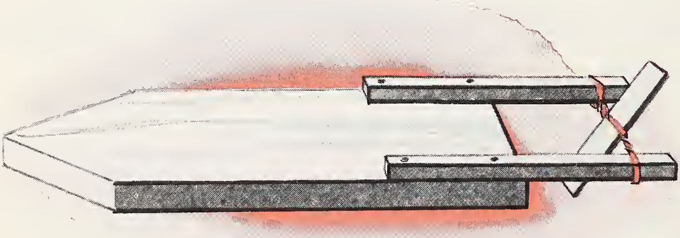
Where was energy stored?

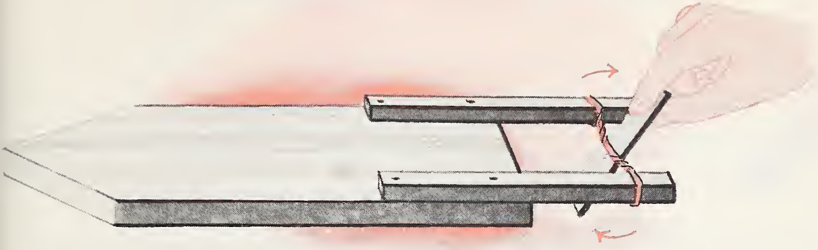


A Toy Boat That Runs

You can make a toy boat.

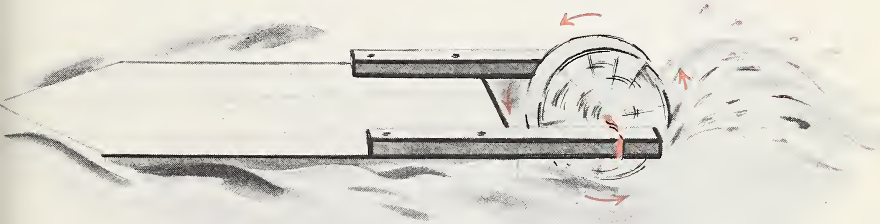
These pictures tell you how to make it.



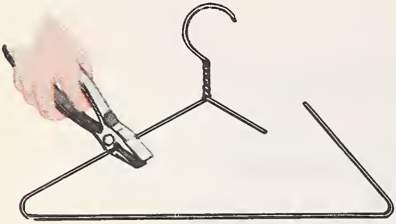


Wind the paddle wheel like this.
Then put the boat in water.
What happens?

What makes the boat move?
How did you give the boat energy?
Where was the energy stored
to make the boat run?



Another Toy That Runs



1

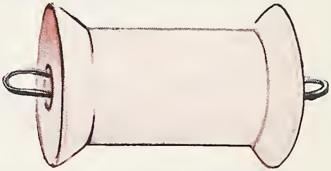
Cut a piece of wire.

2

Bend it like this.

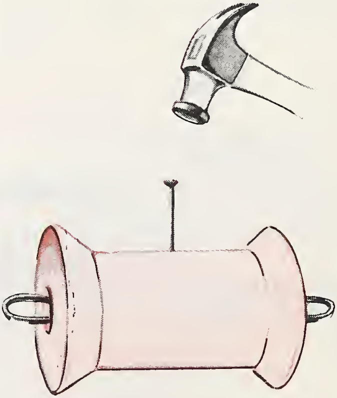
3

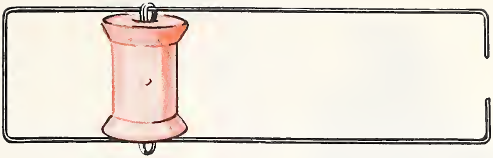
Slip a rubber band through the spool.



4

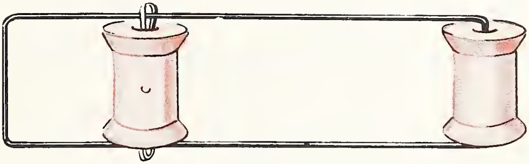
Drive a big tack through the middle of the spool.





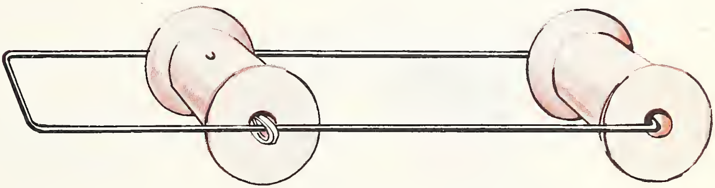
5

Slip the spool on the wire like this.



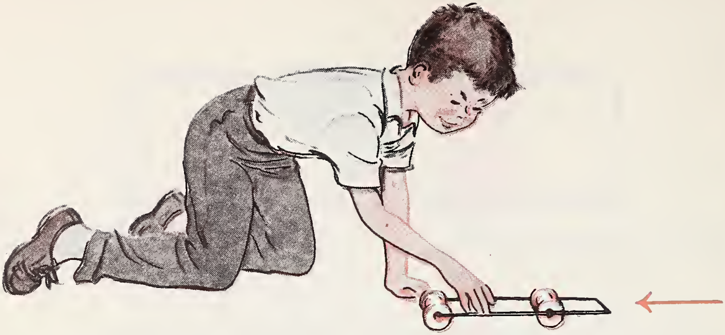
6

Put another spool on the wire like this.



7

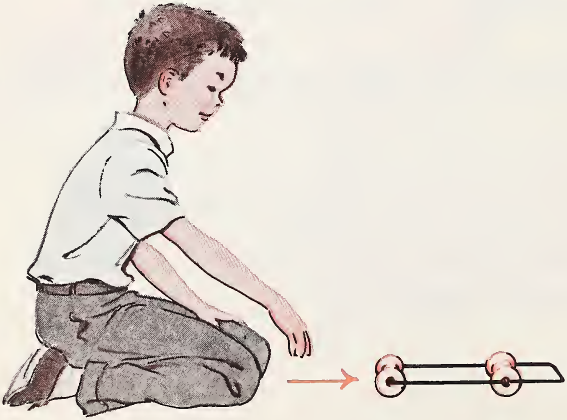
Now you have made a toy.
Do you know how to make it run?
The next pages will tell you how.

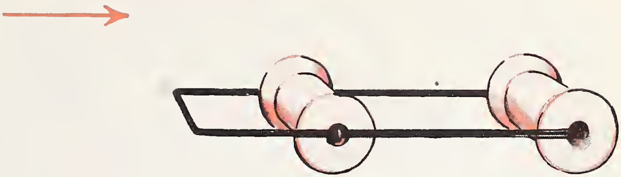


First give the toy some energy.
Pull it across a rug
to wind up the rubber band.

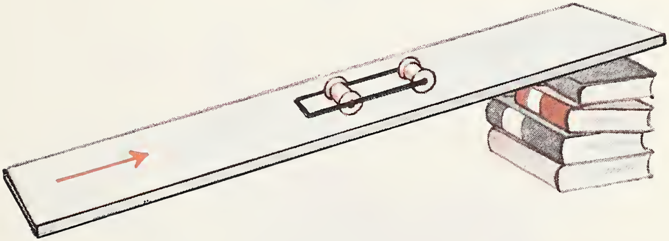
Take your hands from the toy.
The toy will run back
across the rug. Why?

Can you wind up the rubber band
any other way?

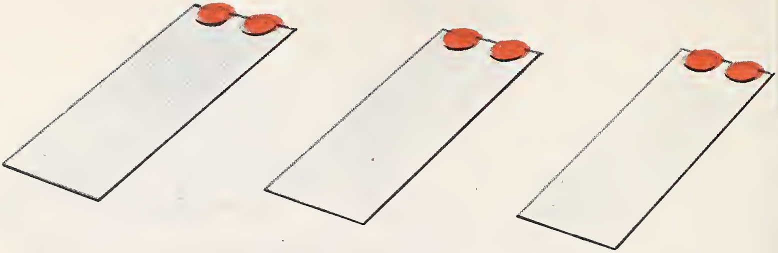




Can you make the toy run backwards?



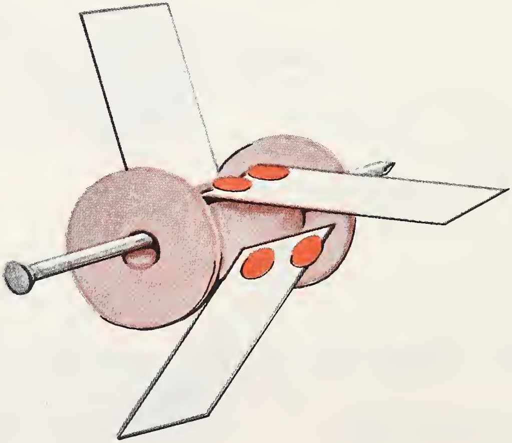
Can you make the toy run uphill?



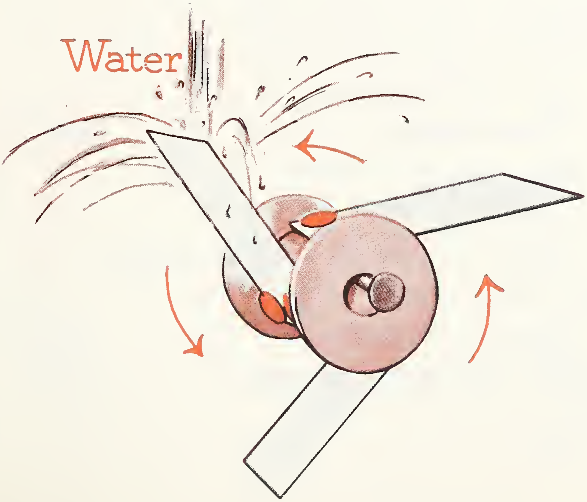
Making a Water Wheel

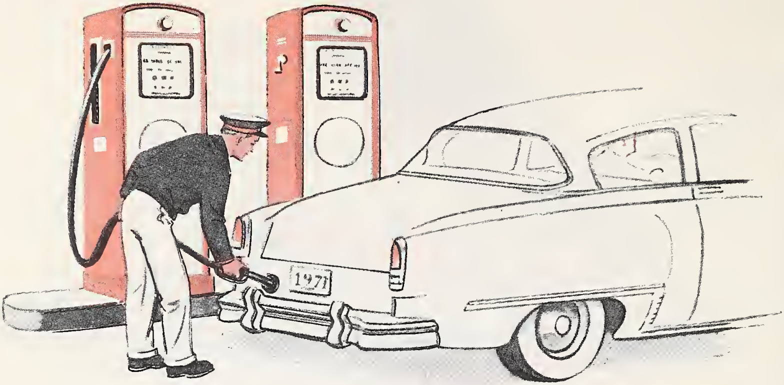
Cut three pieces of cardboard
nearly as wide as a spool.
Push two thumbtacks through each piece
of cardboard.

Fasten the pieces of cardboard
to the spool. Use a big nail
for the spool to turn on.



Hold the water wheel
in some falling water.
Falling water has energy.
The energy makes the wheel turn.



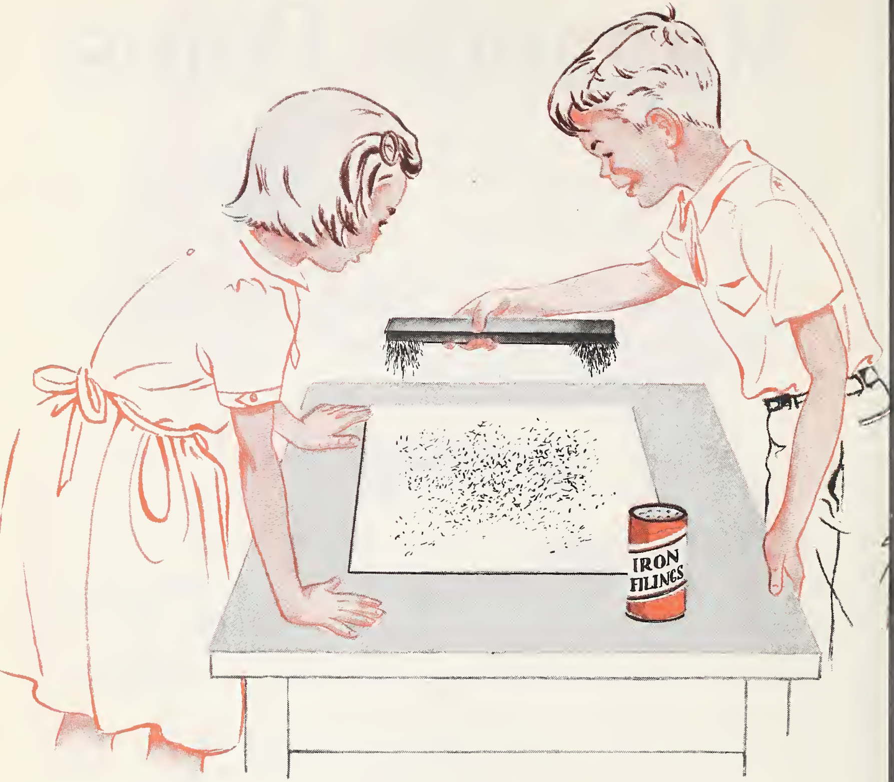


Gasoline has energy. The energy
in gasoline makes an automobile run.
Do you know of other things
that use the energy in gasoline?

---

1. What can energy do?
2. What are some toys
that can store energy?
3. What makes a water wheel turn?
4. How can you store energy
in a rubber band?
5. What are some useful things
energy does for us?
6. How do you know
a spring can store energy?

Magnetic Poles

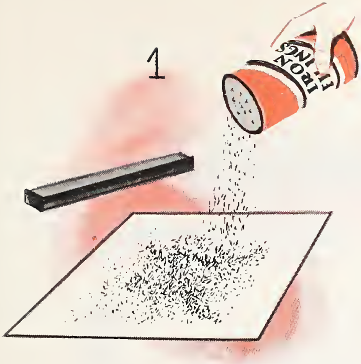


Find the Poles of a Magnet

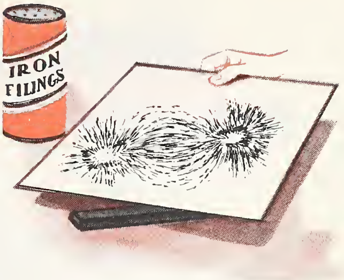
Lay a magnet in some iron filings. Then pick it up. What happens?

The places in a magnet where the pull is strongest are called **magnetic poles.** How many poles has your magnet?

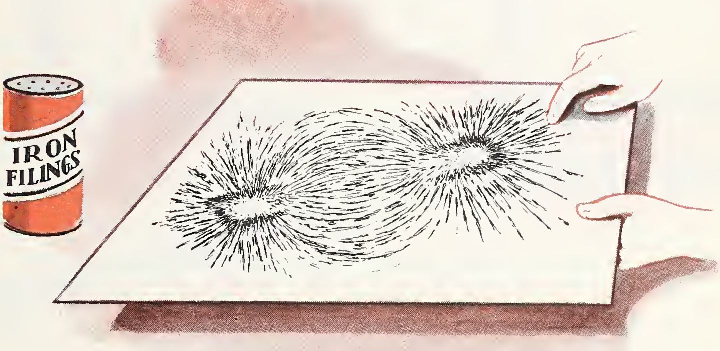
1



2

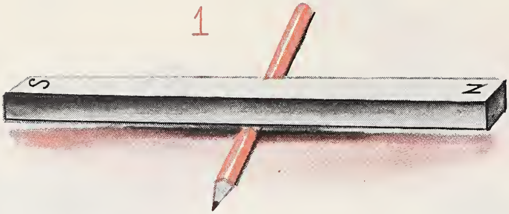


3

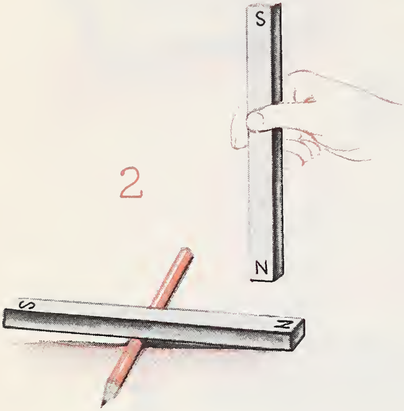


Put some iron filings on a card.
Lay the card on a magnet.
Then tap the card a little.
What happens?
Where do the filings gather?

1



2



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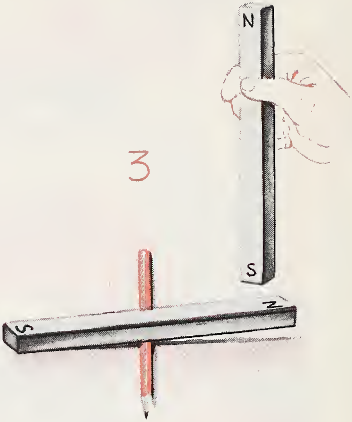
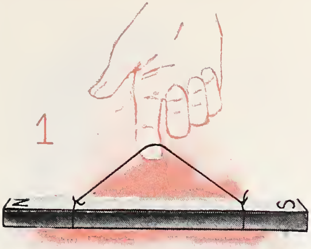


Magnets Push and Pull

If one end of your magnet is marked N, mark the other end S.

Now balance your magnet on a pencil. Hold one end of another magnet near one end of the balanced magnet. What happens? Try the other end of the magnet you are holding.

1



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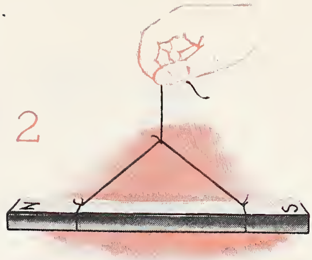
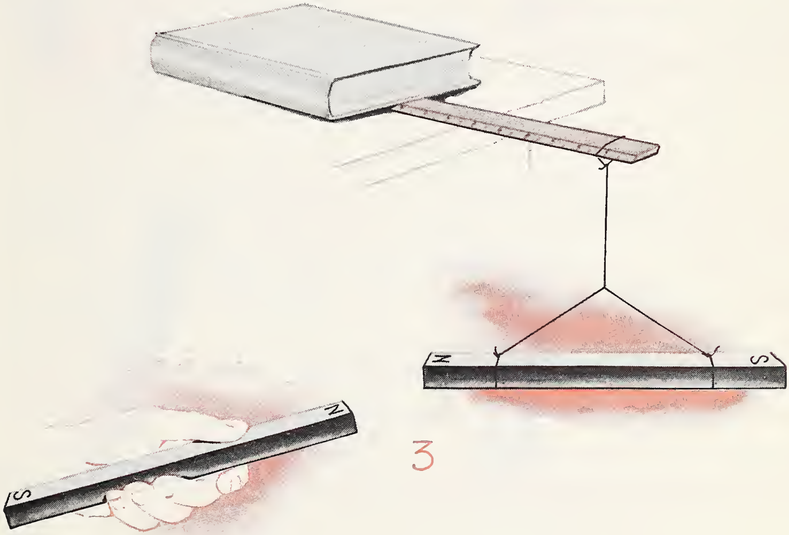
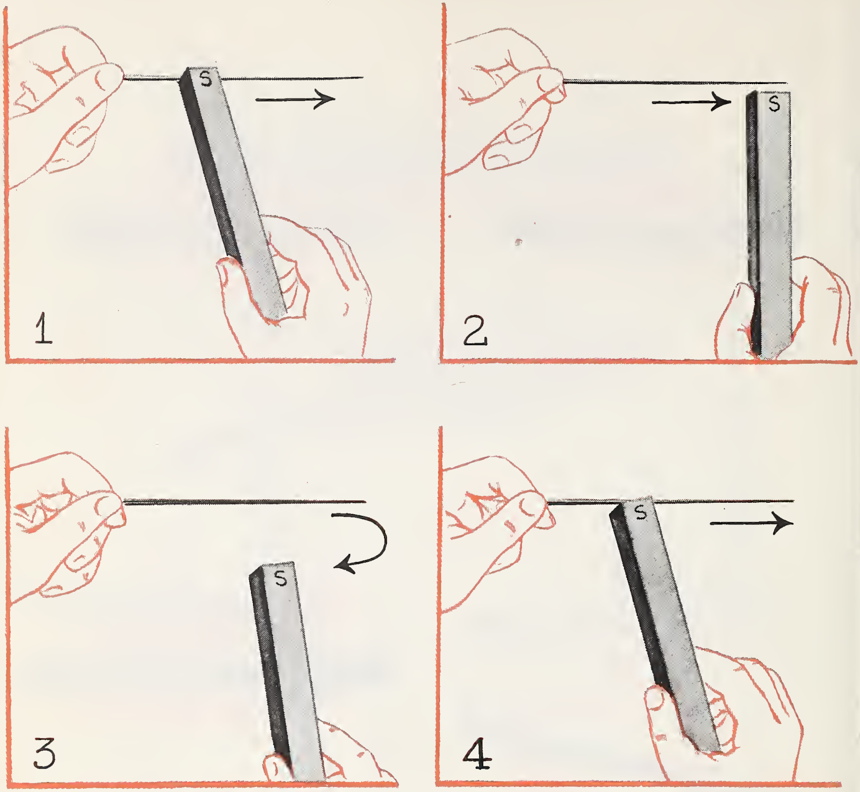




3

Hang a magnet from a ruler.
Hold the N pole of another magnet
near the N pole of the hanging magnet.
What happens?

Try the other pole.



Making a Magnet

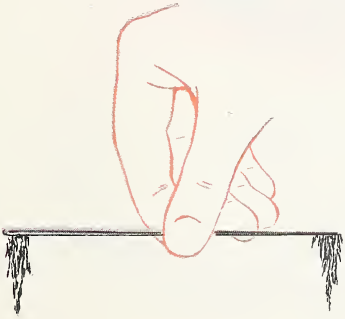
Stroke the pointed end of a needle with a magnet.

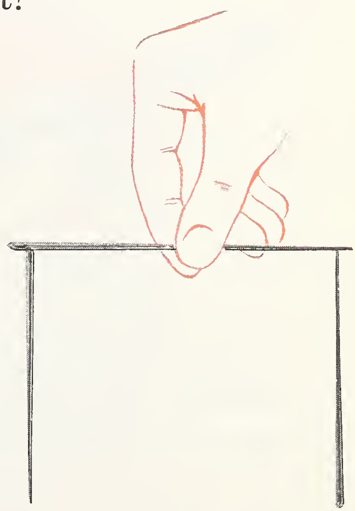
Stroke from the middle of the needle toward the point.

Do this many times.

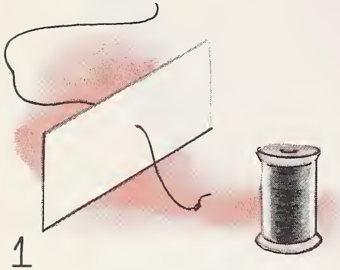
Try to pick up iron filings with your needle.

Try to pick up two other needles. Is your needle a magnet? How do you know?

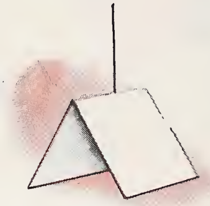




Fun with Needle Magnets



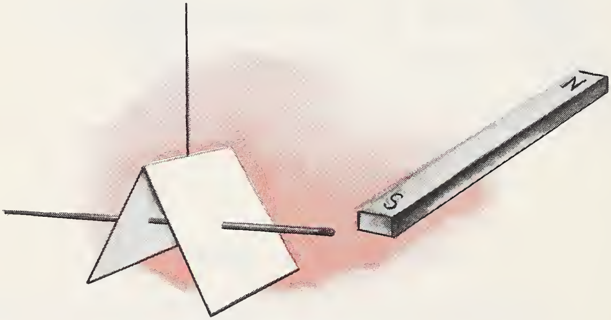
1



2

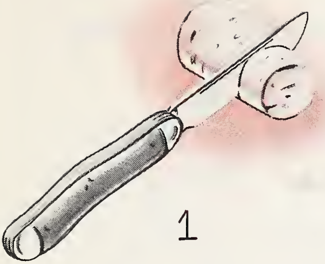
Put a thread
through the middle
of a piece of paper.

Fold the paper
and hang it
by the thread.



3

Push a needle magnet
through the paper. Bring a bar magnet
near the needle. What happens?

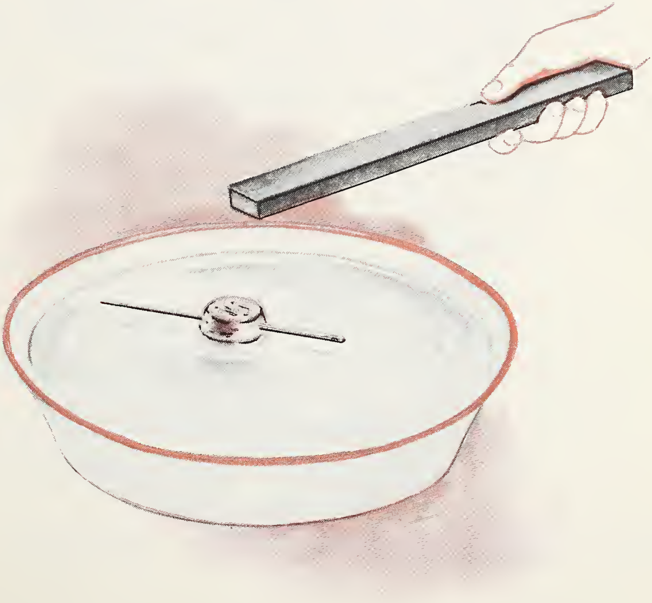


1

2

Cut off a piece of cork.
Push a needle magnet through the cork.
Float the cork in a dish of water.
Bring a magnet near the dish.
What happens?

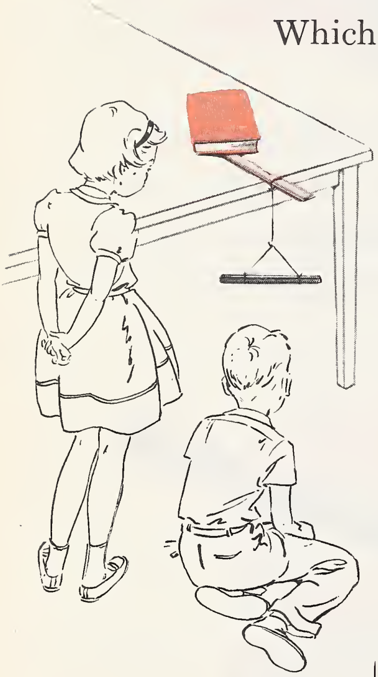
3



North-Pointing and South-Pointing Poles

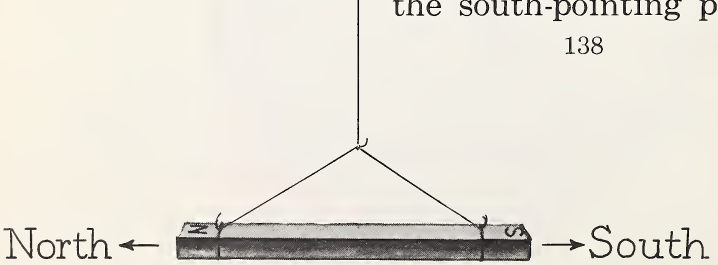
Hang a magnet from a string.
Wait until it stops turning.

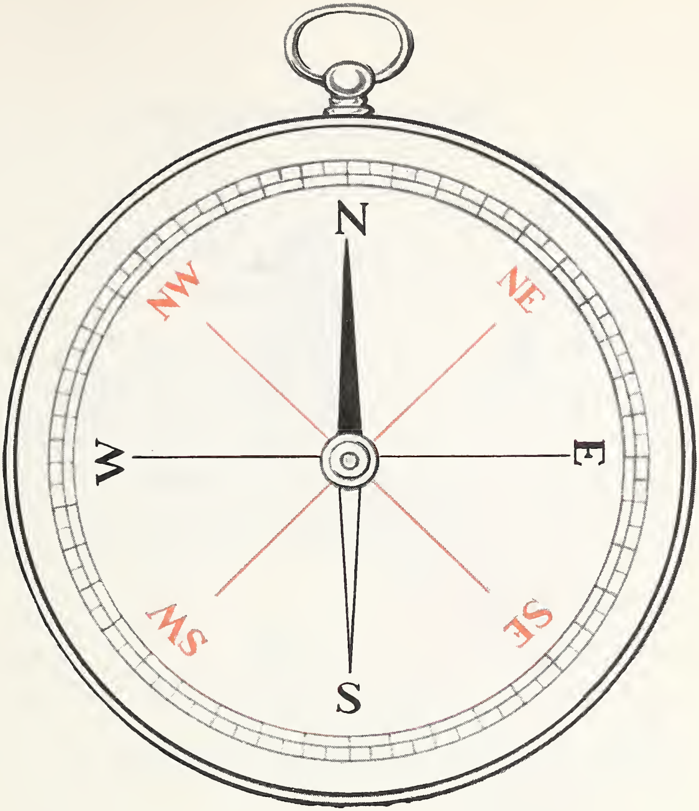
Which end points north?
Which end points south?



One end of a magnet
is marked N
because it points
toward the north.
This end is called
the north-pointing pole.

One end of a magnet
is marked S
because it points
toward the south.
This end is called
the south-pointing pole.



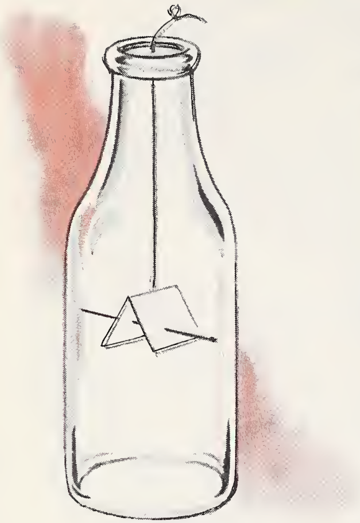


The Compass

The compass needle is a magnet.
One end points north.
One end points south.

Usually, the north-pointing pole is coloured blue or black.

Making Compasses

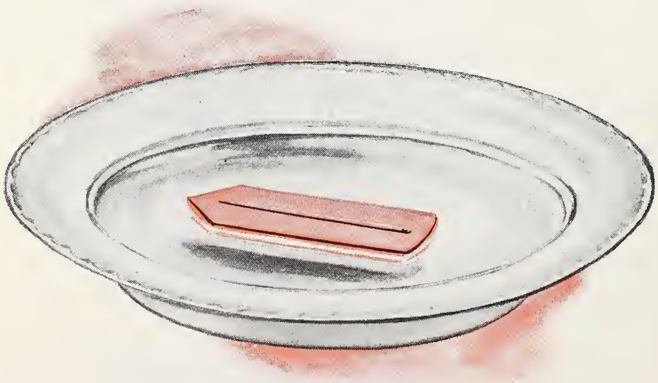


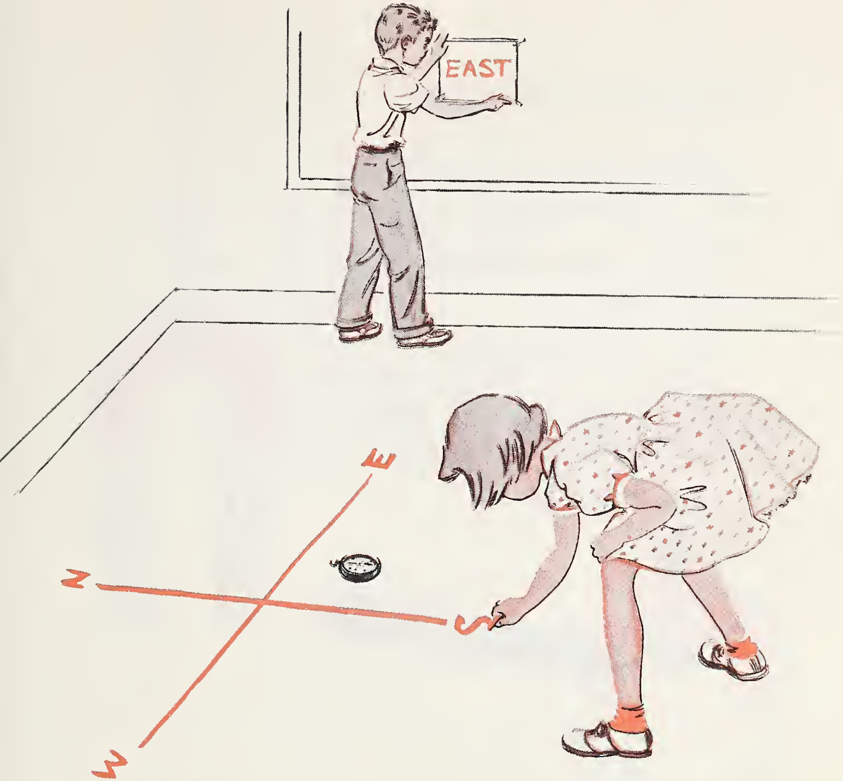
You can make a compass.

Here is one way to make a compass.

What must you do to the needle before you use it?

Here is another kind of compass you can make.





Put a compass on the floor.
Find north, south, east, and west.
Mark them on the floor with chalk.

Mark the walls of the room, too.

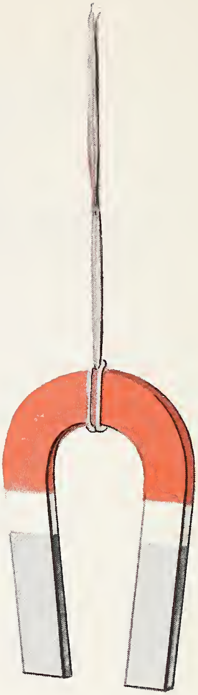
Take the compass outdoors.
Find north, south, east, and west.

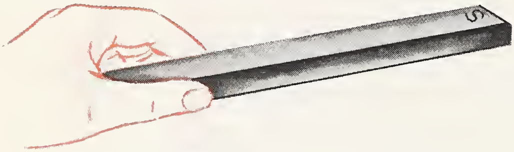
Horseshoe Magnets

Some magnets are shaped like a horseshoe.

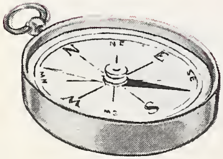
Hang a horseshoe magnet from a string.

Use a bar magnet to find the N and S poles of the horseshoe magnet. Mark the poles.



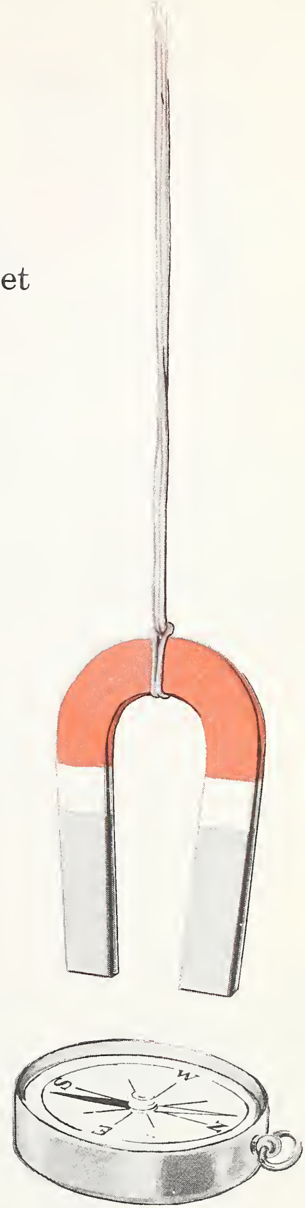


Here is another way to find the N and S poles of a horseshoe magnet.

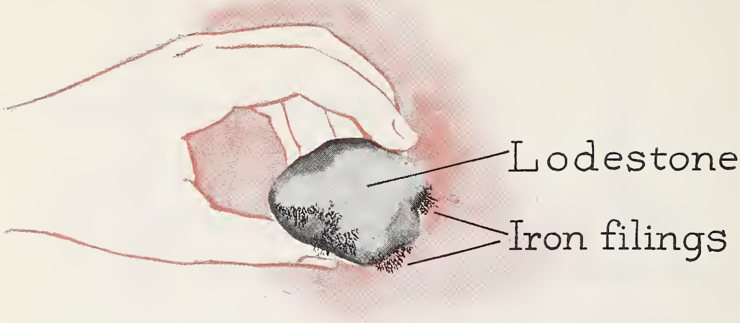


Hang a horseshoe magnet as shown. Put a compass under the magnet.

Turn the magnet and twist the thread. Then let it go.



Watch the compass needle spin. Tell why the compass needle spins.

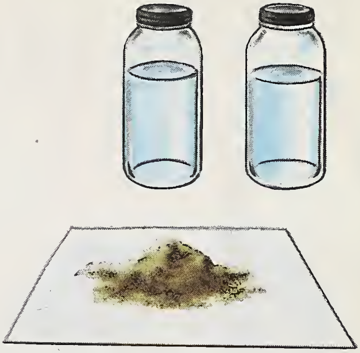


This rock can pick up iron filings.
It is a magnetic rock.
It is called "lodestone."

---

1. How many poles does a bar magnet have?
2. What happens when iron filings are put on a card over a magnet?
3. How can you make a magnet?
4. Do two S poles pull or push each other?
5. Do two N poles pull or push each other?
6. What does a compass do?
7. What are things that magnets pick up usually made of?

Muddy Water

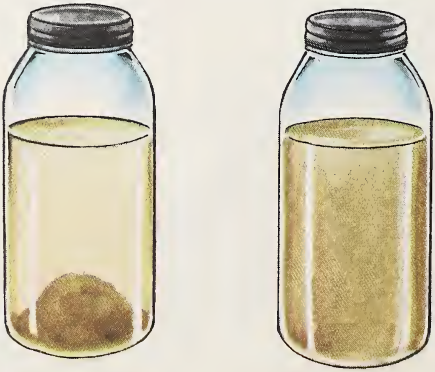


Making Muddy Water

Put the same amount of water into two glass jars. Put a handful of garden soil into each one.

Shake one jar. Do not shake the other jar. What happens?

Does still water or moving water become more muddy?



One day a farmer ploughed a field. The next day it rained hard all day.

Soon there was water running along each gully made by the plough.

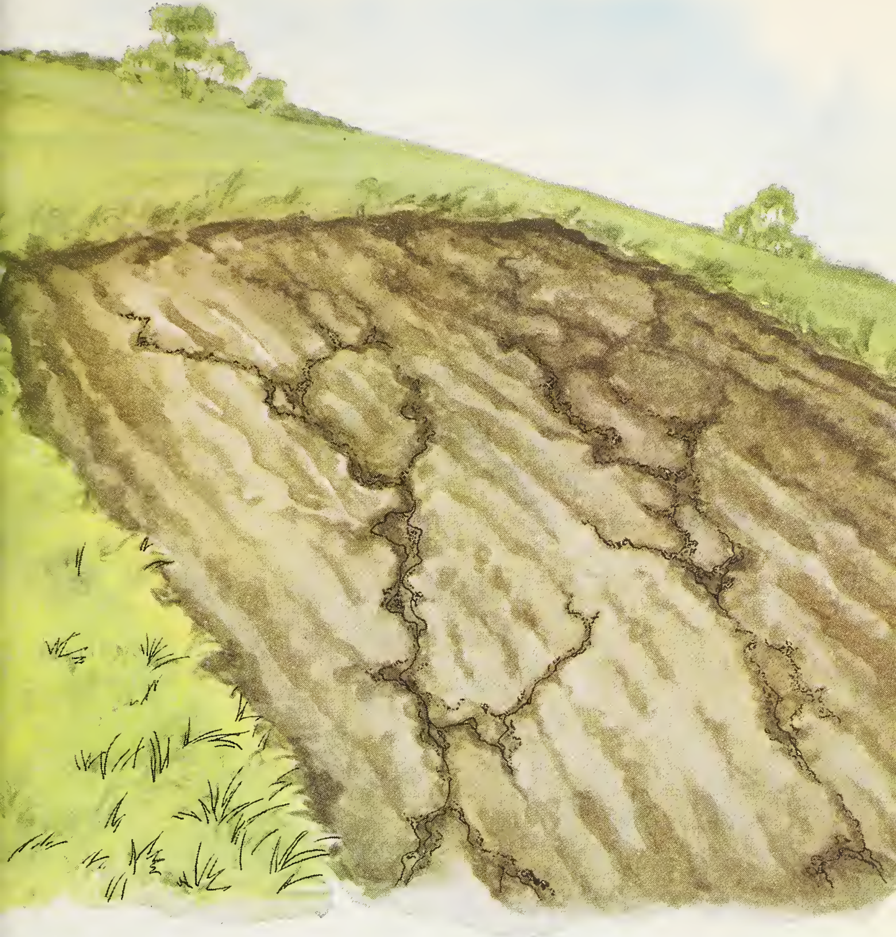
Why did the rain water become muddy?

Running Water Picks up Soil

Make a pile of soil on a sand table or outdoors.

Make little holes in the bottom of a can. Fill the can with water. Sprinkle the pile of soil.

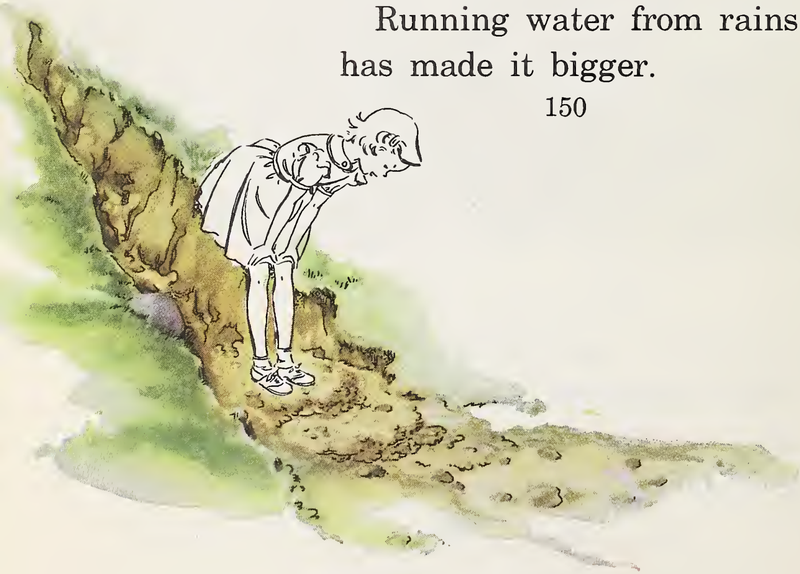
Does the water become muddy? What happens to the pile of soil? Where does some of the soil go?



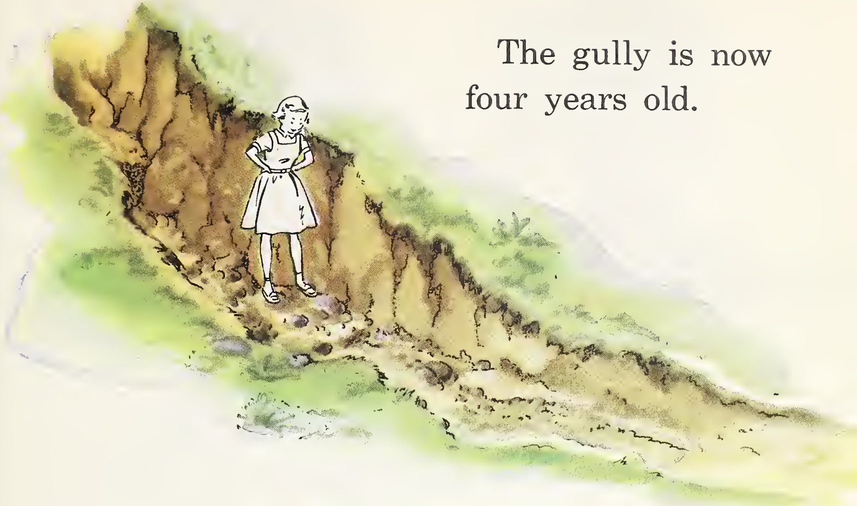
A heavy rain fell on this bare field.
What happened? Is this good
for the field? What harm can it do
to the field?

Here is a gully
that was made
during a heavy rain.

This is the same gully
a year later.
Running water from rains
has made it bigger.

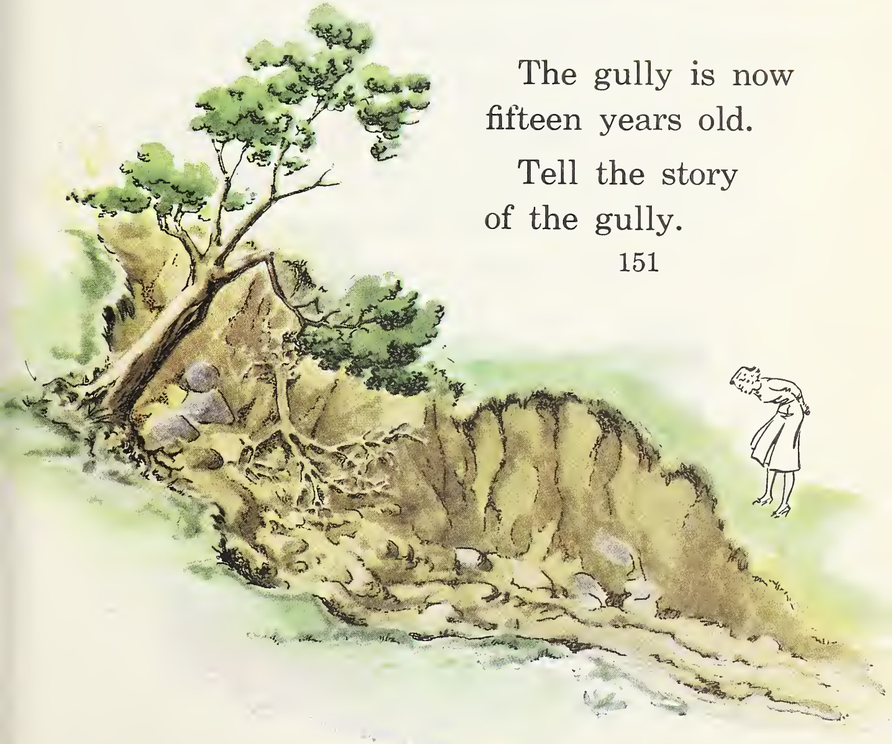


The gully is now
four years old.



The gully is now
fifteen years old.

Tell the story
of the gully.



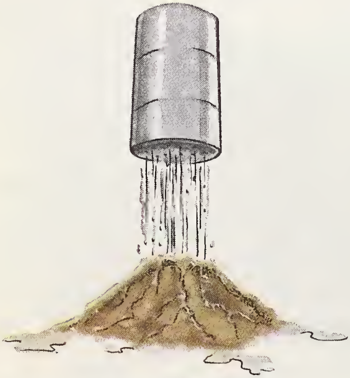
Loose soil

Soil covered with leaves

What Helps Hold the Soil

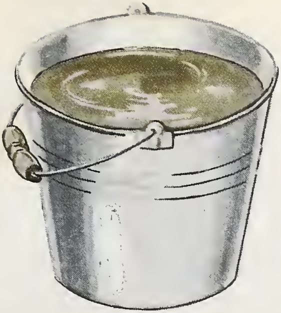
Make two piles of soil. Cover one pile with dead leaves and twigs. Sprinkle the same amount of water on each pile. Which pile washes away faster?

Sprinkle the same amount of water on a pile of loose soil and on a piece of sod. Which washes away faster?



Loose soil

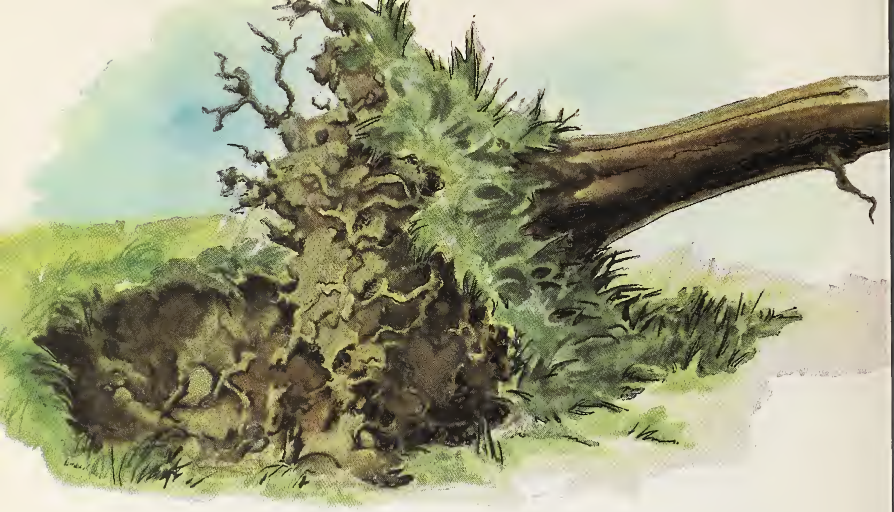
Sod



Dig up a piece of sod.
See how the roots hold the soil.

Wash the sod in a pail of water
until most of the soil is washed away.
Look at the many tiny roots.
Look at the little pieces of soil
that did not wash off.

Can you tell how the grass
helps keep soil from washing away?

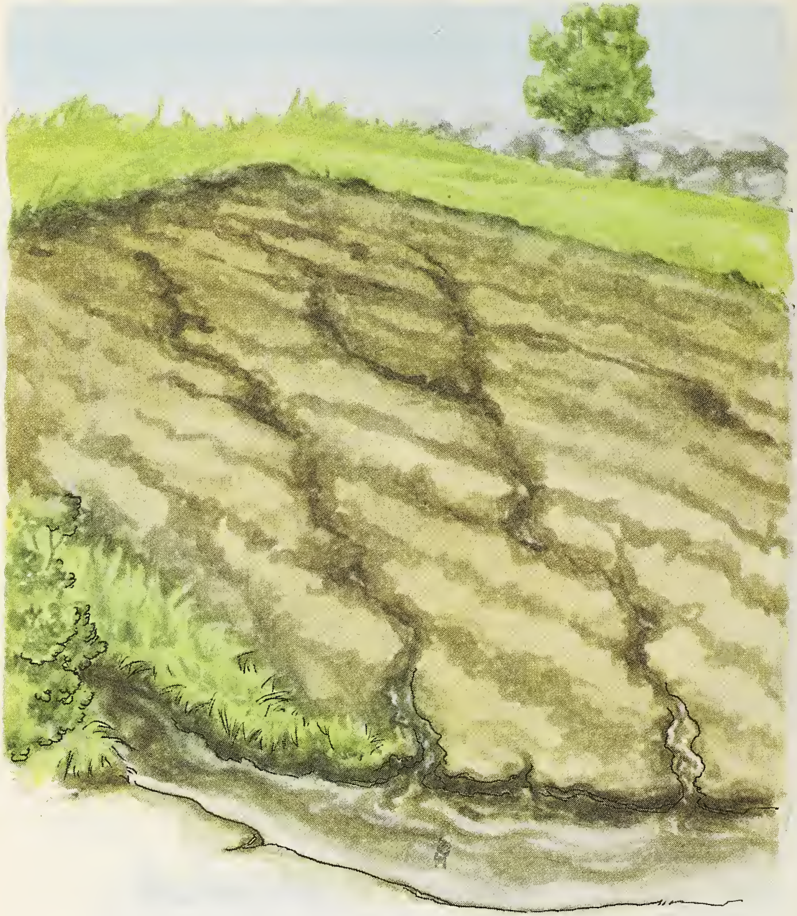


Here is a picture of a tree
that has been blown over by the wind.
See how the roots hold the soil.
The roots of trees help keep the soil
from washing away.

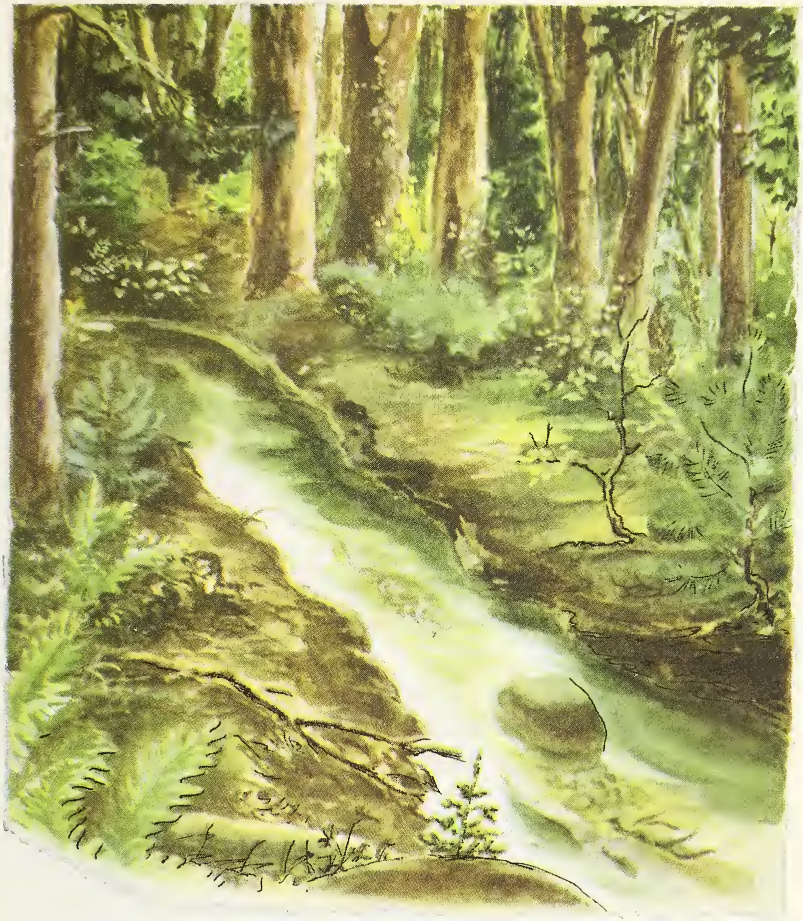
Leaves and twigs that fall from trees
help hold the soil, too. How do they help?

You can plant trees on hillsides to help hold the soil. The roots of the trees will hold more soil as they grow bigger. They will also drop more leaves on the soil as they grow bigger.

How else may trees help us?



There has been a heavy rain
on this bare field all day.
Why is the water in the brook muddy?
Is this helpful or harmful?



There has been a heavy rain
in these woods all day.
The water in the brook is not muddy.
Can you tell why?

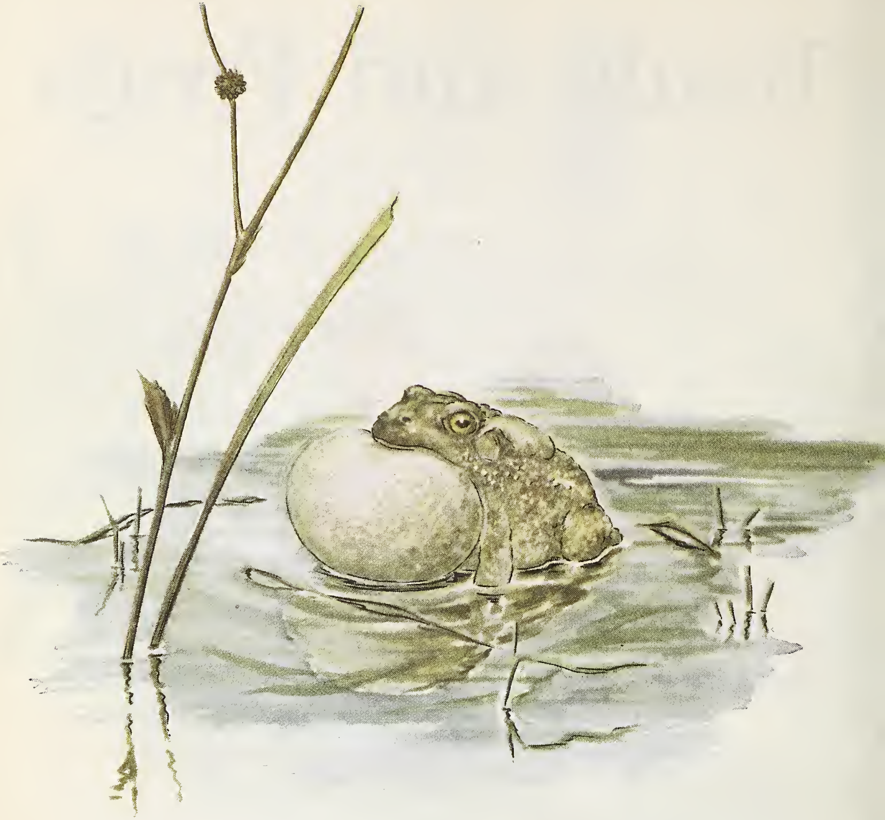
Put some soil in a jar of water.
Stir the water rapidly. Then let it stand.
What happens?

Water slows down
when it runs into a lake.
What happens to soil in the water?

---

1. Why is water often muddy?
2. What may happen to a bare field when it rains?
3. What happens to a gully when water runs through it every year?
4. How does grass help keep soil from washing away?
5. Why do people sometimes plant trees on steep hillsides?
6. Why do farmers like to keep the soil on their fields?

Toads and Frogs

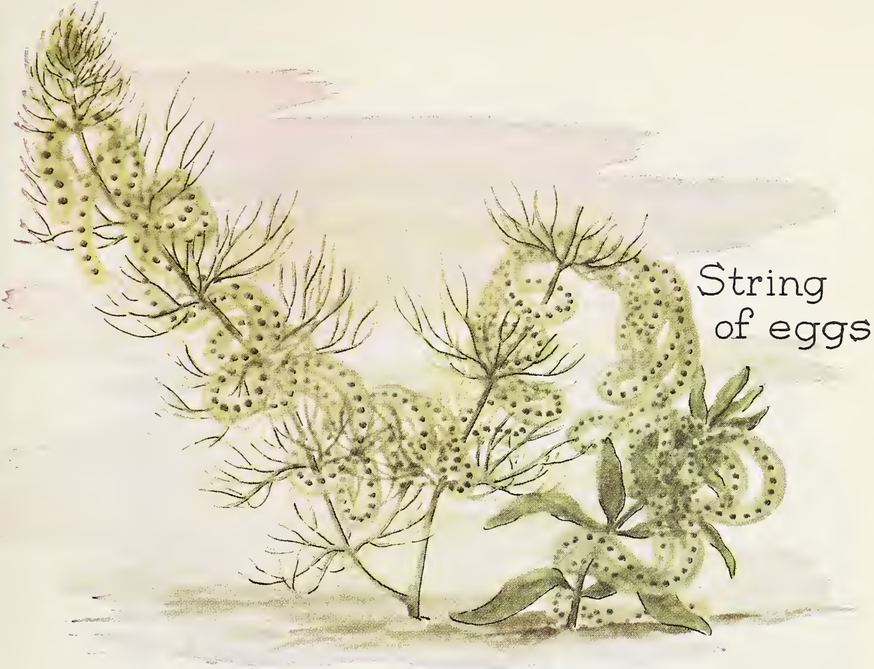


Toads in Spring

Spring has come.

The father toads, called **male** toads, go to pools of water and small ponds.

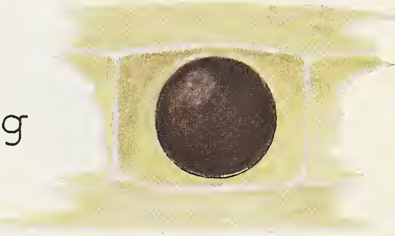
The male toads puff out their throats and make long trilling sounds.



The mother toads, called **female** toads, follow the male toads to the water.

The female toads lay eggs in strings of clear jelly.

Then the male and female toads go back to dry land. They live on land the rest of the year.


Toad's egg

Raising Tadpoles

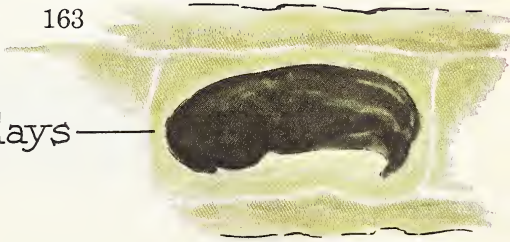
Look for toad eggs on the bottom of a pool of water or a little pond. Put some of the eggs in a jar.

Do not take many eggs.

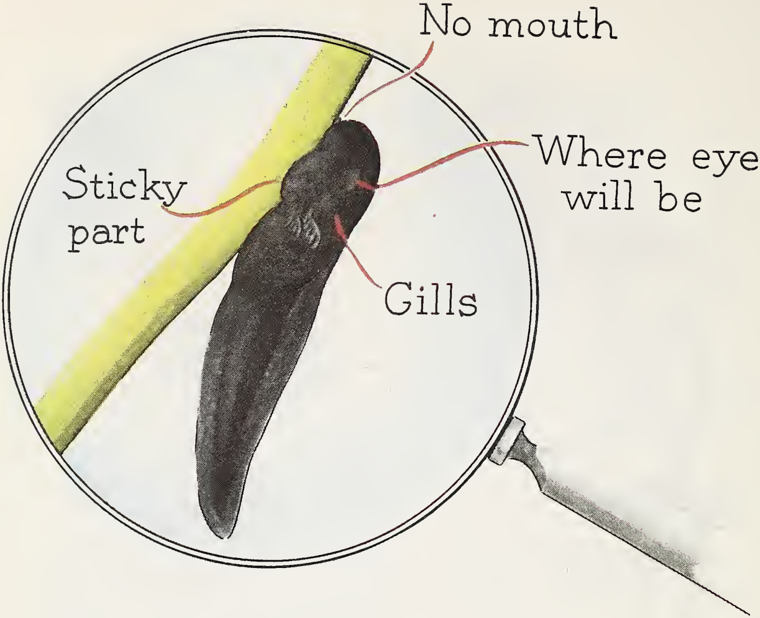
Keep only a few eggs in one jar.

Keep the eggs in a cool room and watch them.

Soon the eggs will begin to change. Little tadpoles will grow from the eggs. The jelly will fall off and the tadpoles will swim away.



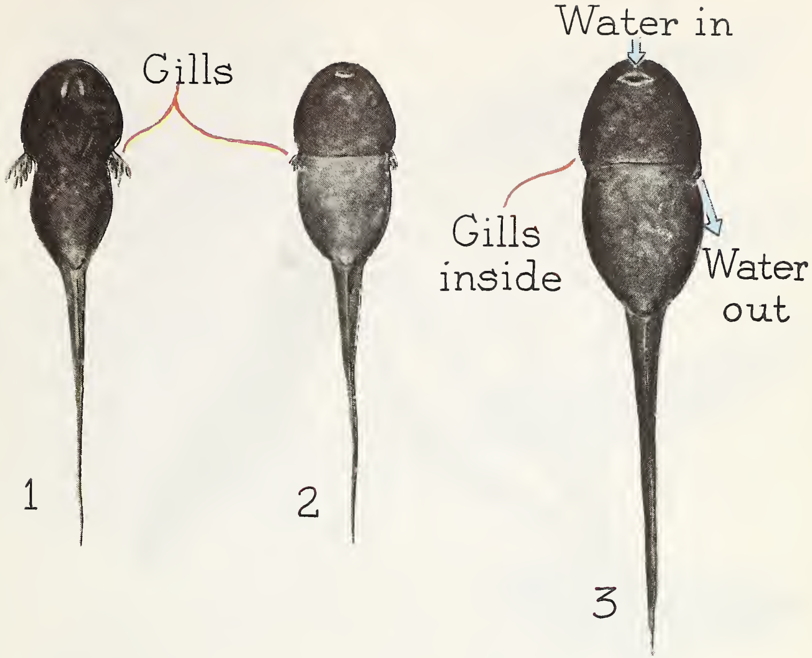
Egg at three days



A little tadpole has no eyes when it comes from the egg. It has no mouth. It uses food that was in the egg.

The tadpole has gills. It takes air from the water with its gills.

Each tadpole has a sticky part. The sticky part helps the tadpole hang on to things.

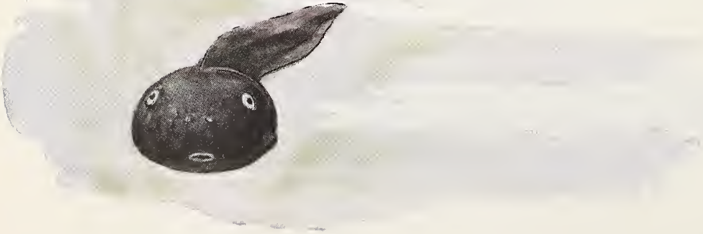


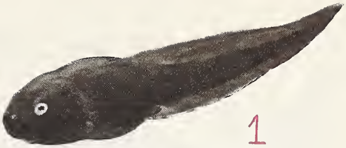
The tadpole changes in many ways as it grows.

Skin grows over the gills. The eyes begin to show. The mouth opens.

The tadpole begins to look for food.
There are many tiny plants
and animals living in the water.

The tadpole eats these
tiny living things.





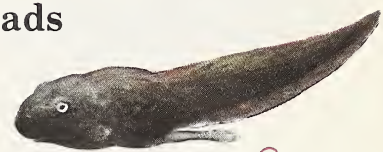
1

Tadpoles Become Toads

When a toad tadpole is about two months old, it begins to change to a toad.

Look at the pictures.

What are some of the changes that a tadpole makes as it becomes a toad?



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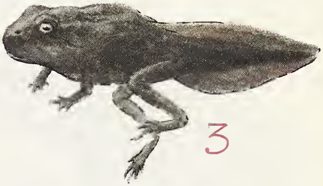

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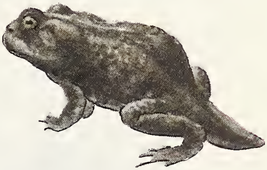

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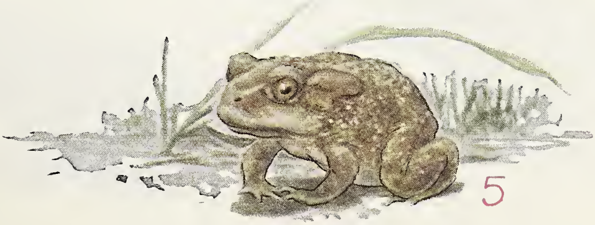
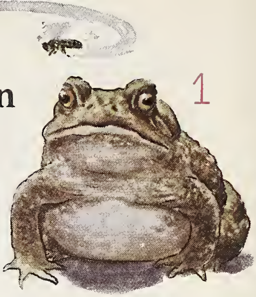


5

Toads Eat and Are Eaten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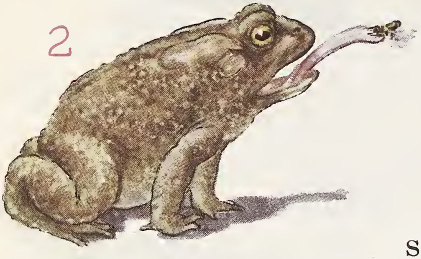
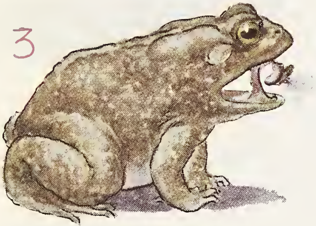

2

A toad has a long,
sticky tongue.
Look at the pictures.
How does the toad
catch an insect
with its sticky tongue.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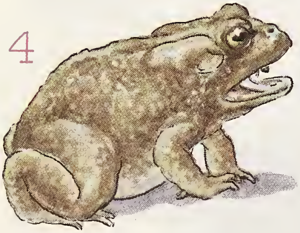
A toad shuts its eyes
when it swallows
something big.
Maybe this helps
the toad swallow.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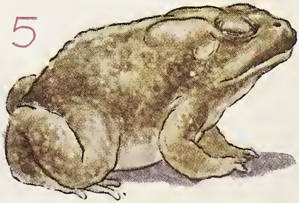
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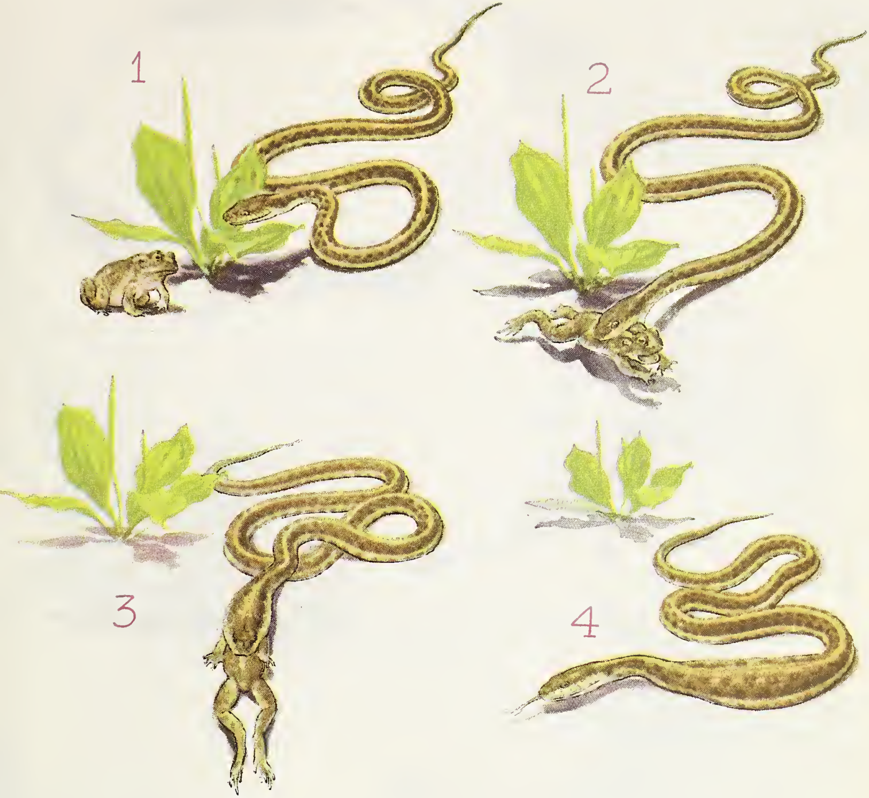
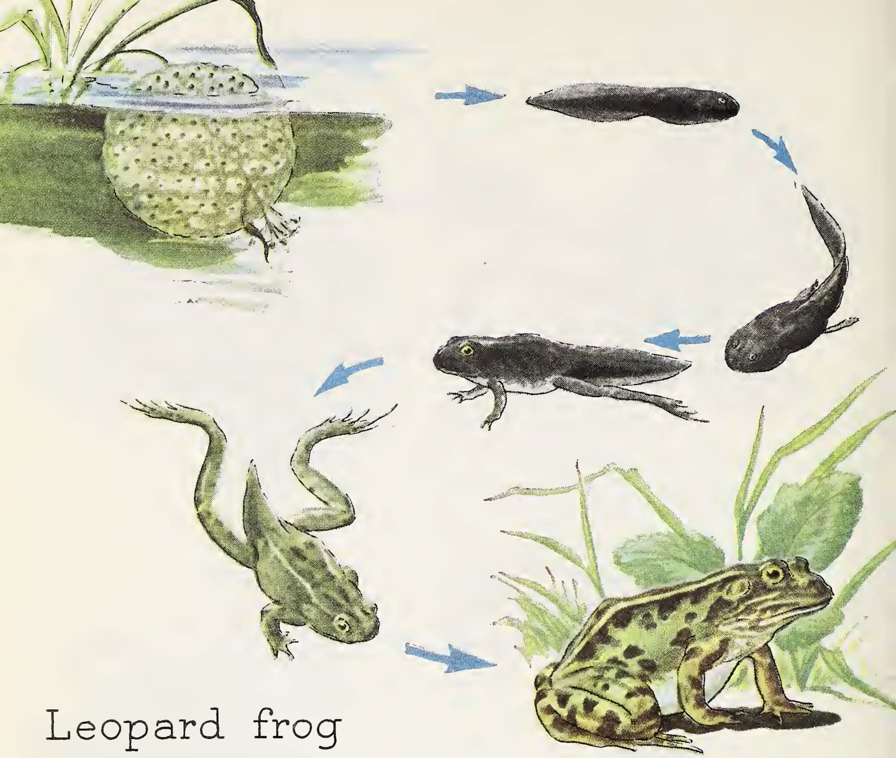


Many animals do not like to eat toads.
The toads do not taste good.

But snakes eat many toads.
They do not seem to mind the taste.

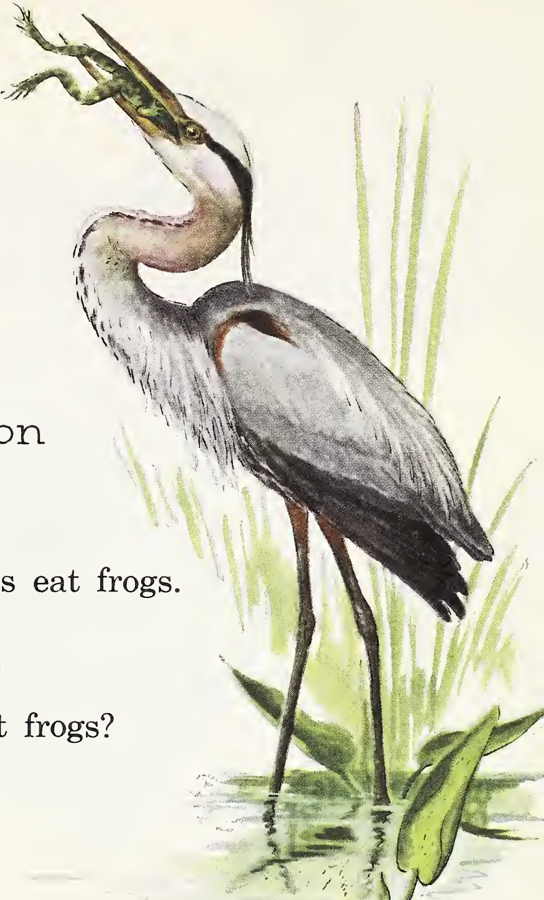


Leopard frog

Frogs

Frogs are something like toads.
Their eggs change into frog tadpoles.
Then the tadpoles change into frogs.

Find the eggs of a frog and
watch them change into tadpoles.
Read about different kinds of frogs.



Heron

Many animals eat frogs.
Can you name
some of them?

Do people eat frogs?

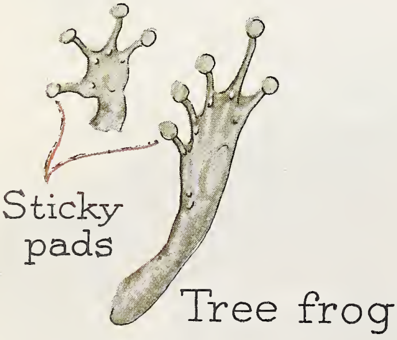
Pike

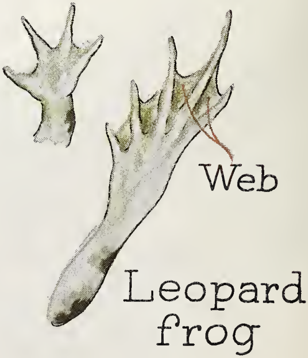
Tree Frogs

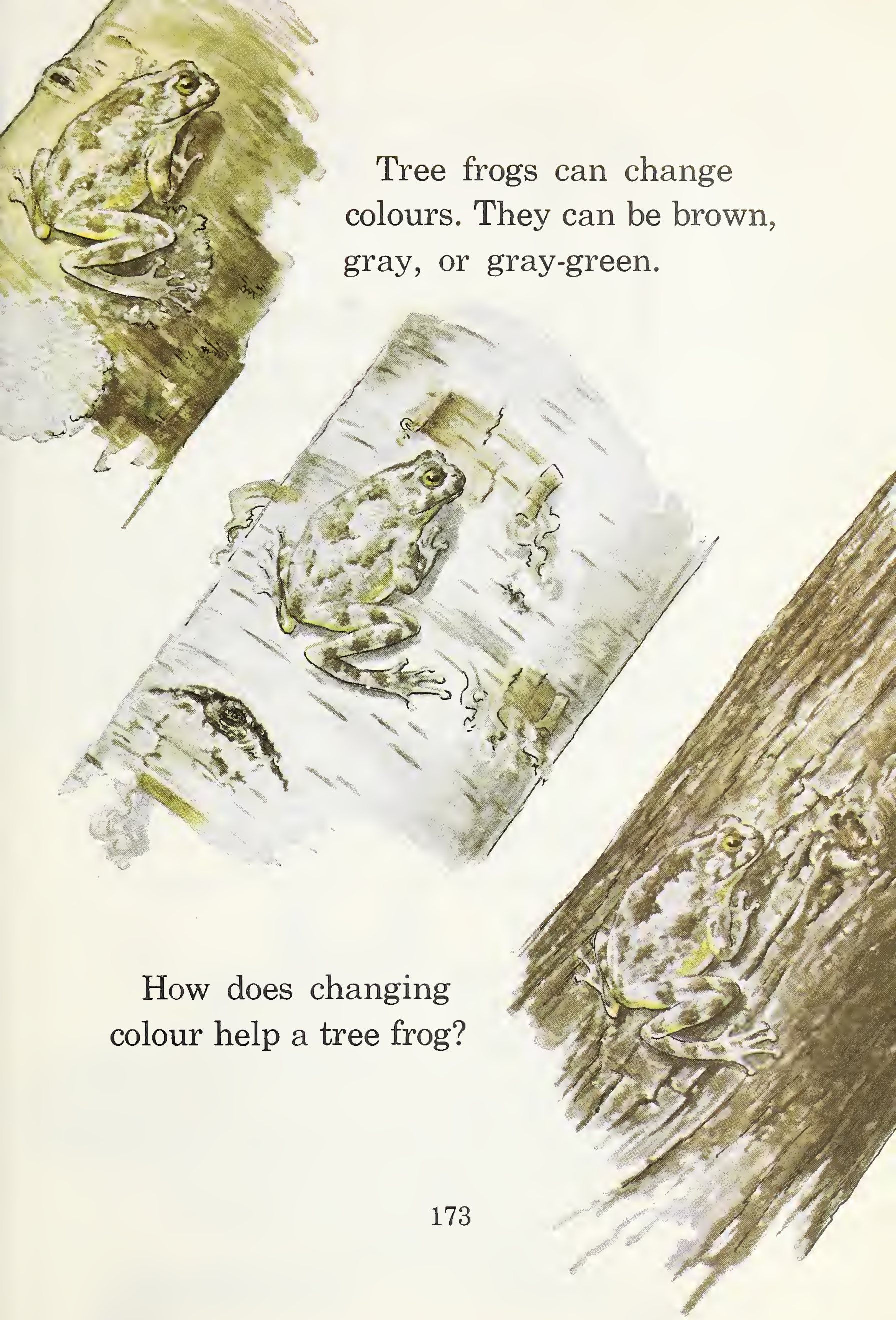
Tree frogs are something like toads.

Tree frogs lay their eggs in water.
The eggs change into tadpoles.
The tadpoles change into tree frogs.

Tree frogs spend their time in trees and bushes. They have sticky pads on their toes. They use the sticky pads when they climb.

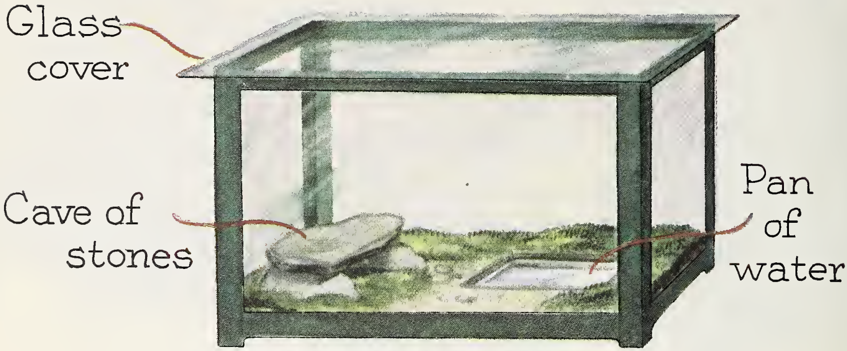






Tree frogs can change colours. They can be brown, gray, or gray-green.

How does changing colour help a tree frog?



You can keep a toad or a frog in a glass cage. Give it a place to hide and keep the inside damp.

Feed the toad or the frog live insects or live fishworms.

---

1. Where do toads lay their eggs?
2. How can you tell the eggs of toads from other eggs?
3. What are some changes you can see as a tadpole becomes a toad?
4. What do tadpoles eat? What do toads eat?
5. What is one way a tree frog is different from a toad or a frog?

Grass

Grass Is Important

Grass is important to everyone. We use grass in many ways.

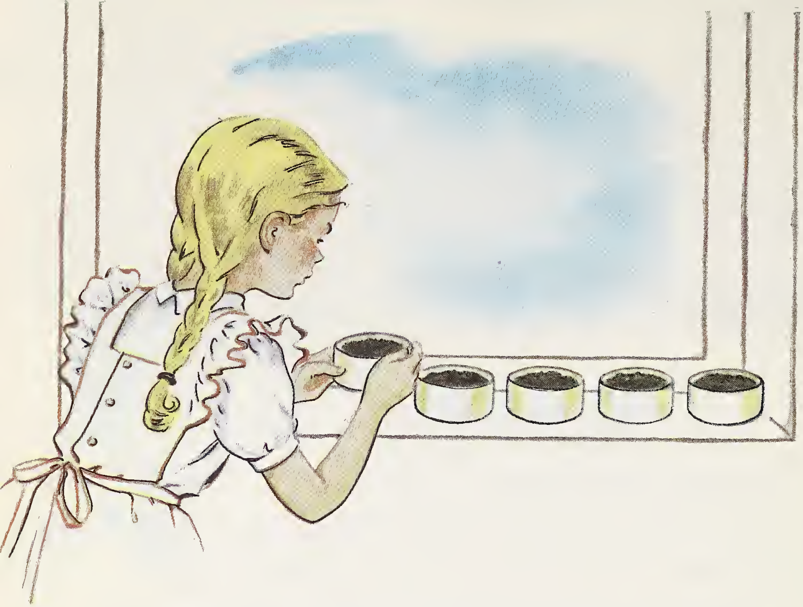
Many animals eat grass. What are some of the animals that eat grass? How do people use these animals? What do these animals give us?

Collect pictures of the things which come from the animals that eat grass.

Many people plant grass
around their homes. The grass
makes the houses look better.
It helps cool the air on hot summer days.

Where else do people plant lawn grass?
What are some games
that are played on grass?

Grass also helps to keep soil
from washing away.
How does the grass help hold the soil?



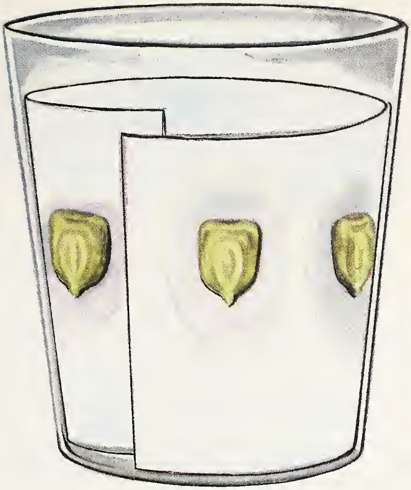
What Grass Plants Are Like

Plant different kinds of grass seeds. Keep the soil damp but not wet.

Plant other kinds of seeds, too. Plant peas and beans.

How are the young grass plants alike? How are the grass plants different from the other plants you are growing?

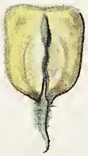
Plant grains of corn and wheat. Are the young plants like young grass plants or like young peas and beans?

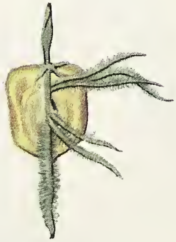


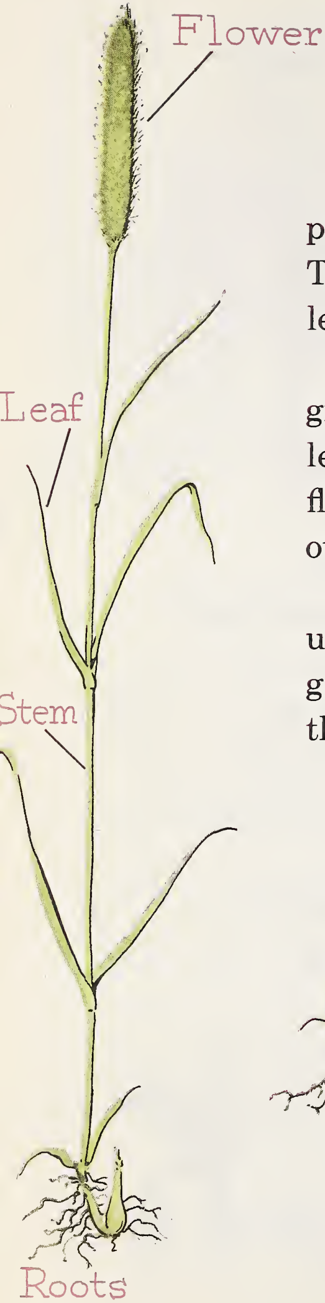
Place a piece of paper towel
around the inside of a drinking glass.
Put some grains of corn
between the towel and the glass.
Keep the towel damp but not wet.

Plant other kinds of seeds this way.
Watch them grow.

Keep a record of what happens
by drawing pictures.



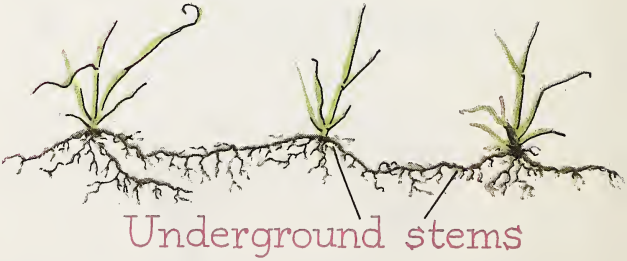


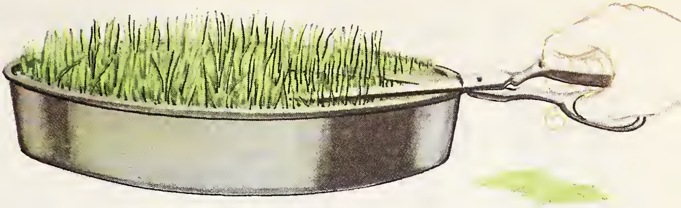


Grass plants have the same parts as many other plants. They have roots, stems, leaves, and flowers.

Bring in some different grass plants. What are the leaves like? How are the flowers different from many other flowers?

Find a grass plant that has underground stems. Do new grass plants grow from these stems?





Dig up a piece of sod and plant it in a pan. Keep it damp but not wet. Cut off the grass with shears. Then watch the plants grow again.

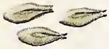
Where do the leaves and stems grow? Do they grow at the top, at the bottom, or at places in between?

Grass in lawns is cut about once each week in summer. Some kinds are better for lawns than others because their leaves grow closer to the ground. A mower does not cut them all off.

Oats

Wheat

Food from Grass



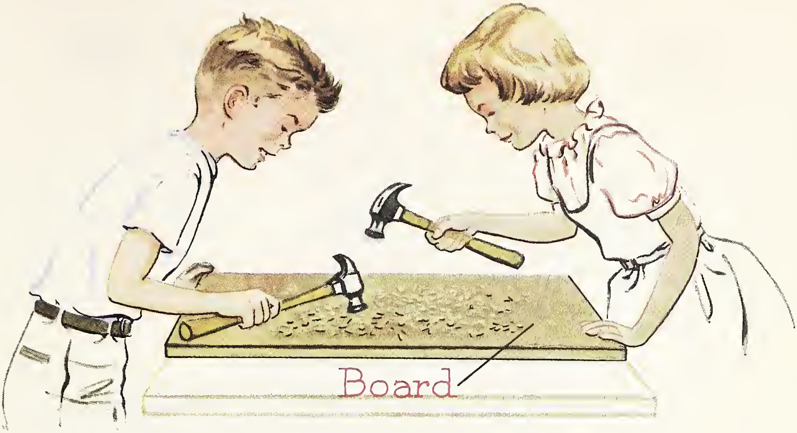
Some of our most important foods come from grass. People usually eat only the seeds of the grass.

Rye

Here are some different kinds of grass seeds that people eat. Rye flour is used for bread. Barley is often used in soup. How are the other kinds of grass seed used?

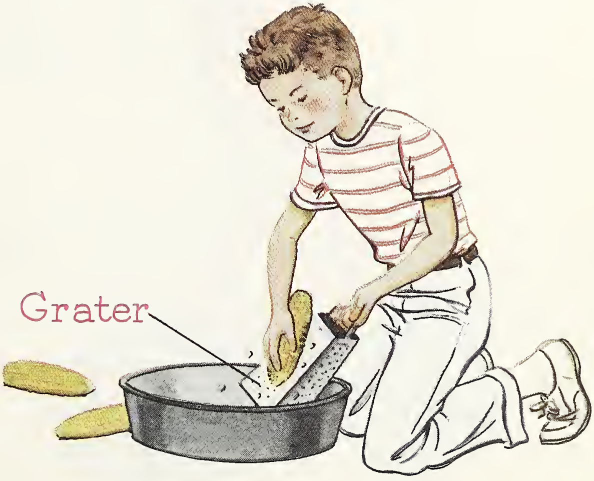
Barley

Rice



You can make rolled oats by pounding oat grains carefully. Pounding the grains makes the outside parts come off.

You can make corn meal, too. You will need some ears of dry corn. What is corn meal used for?



Grains of wheat

Most of our bread today
is made of wheat flour.

You can make some wheat flour
the way people did years ago.

You will need a round stone, a flat stone,
and some grains of wheat.

Crush and grind the grains of wheat
between the stones. Keep grinding
until the grain is very fine.

Sift the ground wheat through a cloth.
The flour goes through the cloth.
The parts that are left are called bran.

What is whole wheat flour?
How is bran used?
How is sifted flour used?

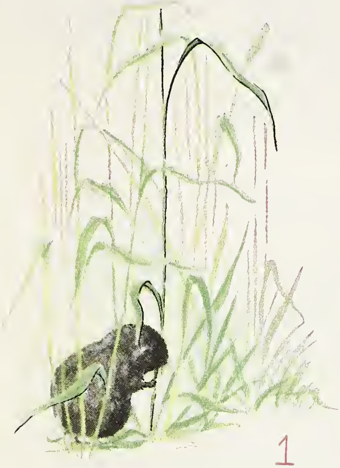
Bran

Flour

How Wild Animals Use Grass

Here are some ways birds use grass.
What are some other animals
that use grass?

Look at these pictures and tell how the meadow mouse got his dinner.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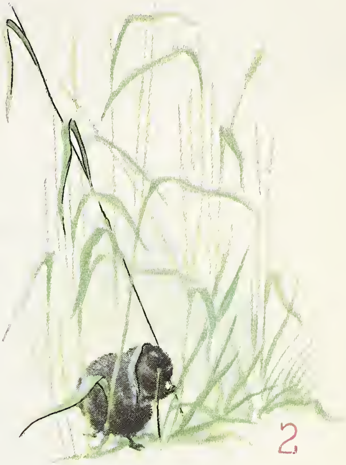
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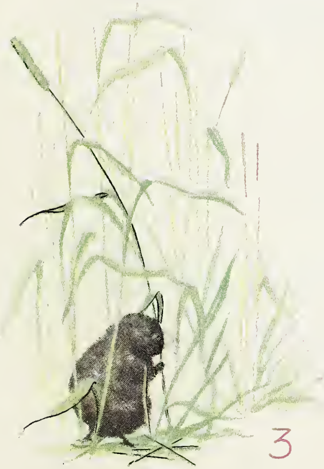
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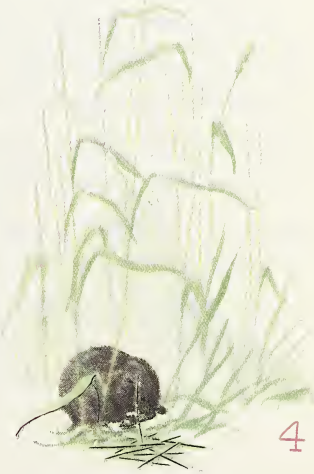
4

Making Hay

Hay is fed to animals in winter
when grass does not grow.

Find out how hay is made.
What animals eat hay?

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1. Name some animals that eat grass.
2. Name some grasses
that are important to us.
3. Name some foods
that come from grasses.
4. What are some ways
grass plants are alike?
5. How do wild animals use grasses?
6. How is wheat flour made?
7. Why do we plant lawns?

The Major Topics
Presented in Each Unit

* **Unit 1 — Sunshine.** What sunlight does to water, soil, and living things. How sunlight changes through the year. What moonlight is.

Unit 2—Travelling Seeds. Some common plants that have seeds. How seeds are scattered. Why we find plants in new places.

* **Unit 3 — Hearing Sounds.** What our ears are like. How we can take care of our ears. How sounds travel.

* **Unit 4 — Fire and Air.** What happens when a fire does not have fresh air. How fires can be extinguished. Some rules for safety with fire.

* **Unit 5 — Teeth.** What our teeth are like. What the teeth of some animals are like. How we can take care of our teeth.

Unit 6 — Animals in Winter. What some common animals do when winter comes. How we can study animals in winter.

* **Unit 7 — Water in the Air.** What happens to water when it dries. What makes water come out of the air. What causes dew, frost, rain, and clouds.

Unit 8 — Making Things Move. What energy can do. How energy can be stored. Some things that use energy.

Unit 9 — Magnetic Poles. What magnetic poles are. What magnetic poles do to each other. How we use magnetic poles for finding directions.

Unit 10 — Muddy Water. What running water does to soil. Why it is wise to protect the soil. How plants help protect the soil.

Unit 11 — Toads and Frogs. How toads and frogs change as they grow up. What toads and frogs eat. Some animals that eat toads and frogs.

Unit 12 — Grass. Why grass is important to us. How grass grows. Why grass is important to many wild animals.

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* These units include health and safety material.

Subject Index

The topics covered by *Exploring Science Three* have been indexed for the convenience of teachers who wish to refer quickly to specific subjects. Many of the references are to pictures, pictures having been used extensively to give information and directions for activities.

Not all words listed below, therefore, are included in the reading material for the children; but the starred words are included. These words represent the special science vocabulary introduced and developed in this book. A complete list of the words introduced in this book is included in the Teachers' Edition.

The vocabulary of *Exploring Science Three* has been checked against standard word lists. The reading level has been kept well below that of standard third-grade readers.

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